Online Appendix to:

The Economic Effects of the Abolition of Serfdom: Evidence from the Russian Empire

By ANDREI MARKEVICH AND EKATERINA ZHURAVSKAYA

Contents:

# **Appendix Figures**

Figure A1. The results of a survey conducted in 1872 by a special government commission to evaluate the results of the abolition of serfdom (% of respondents with each answer)
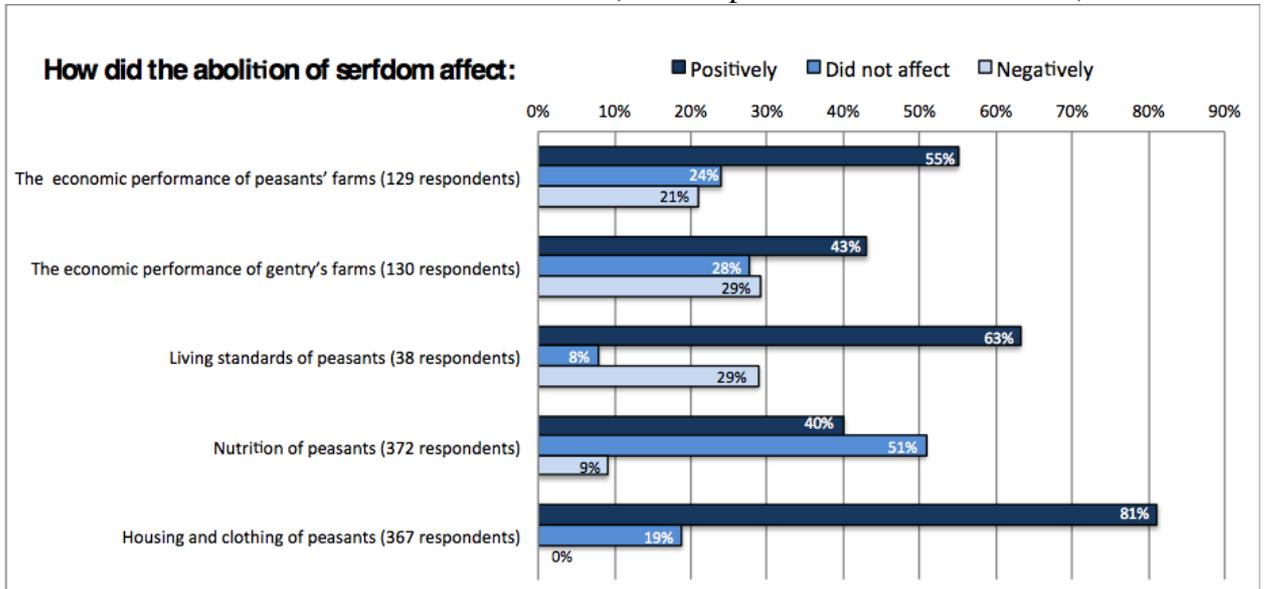
Figure A2. Geography of serfdom: the share of serfs in 1858 and the distance from Moscow
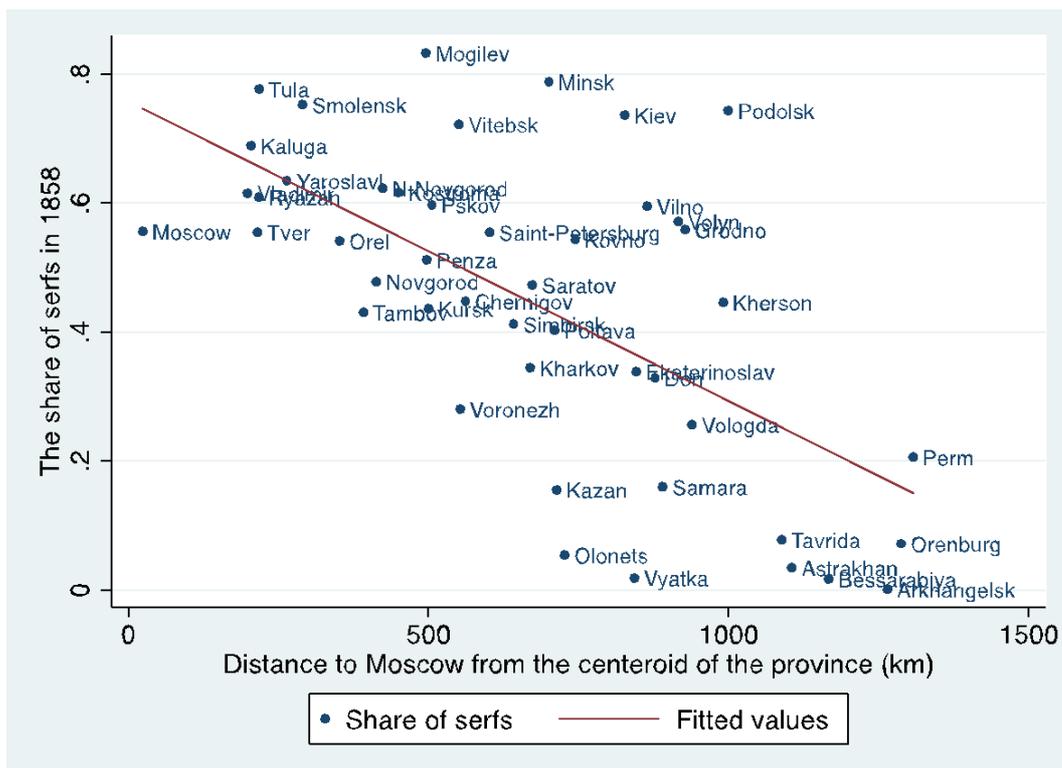
Coef: -0.0005; SE=0.00009; R^2 =0.36.

Figure A3. Geography of free labor: state peasants and free agricultural workers
Panel A. State peasants in 1858 as a share of rural population

Legend
Share of state pesants, 1858 (deciles)
- 0% - 13,6%
- 13,7% - 20%
- 20,1% - 22%
- 22,1% - 30%
- 30,1% - 34,6%
- 34,7% - 37,7%
- 37,8% - 52,5%
- 52,6% - 55,7%
- 55,8% - 67,4%
- 67,5% - 88,2%
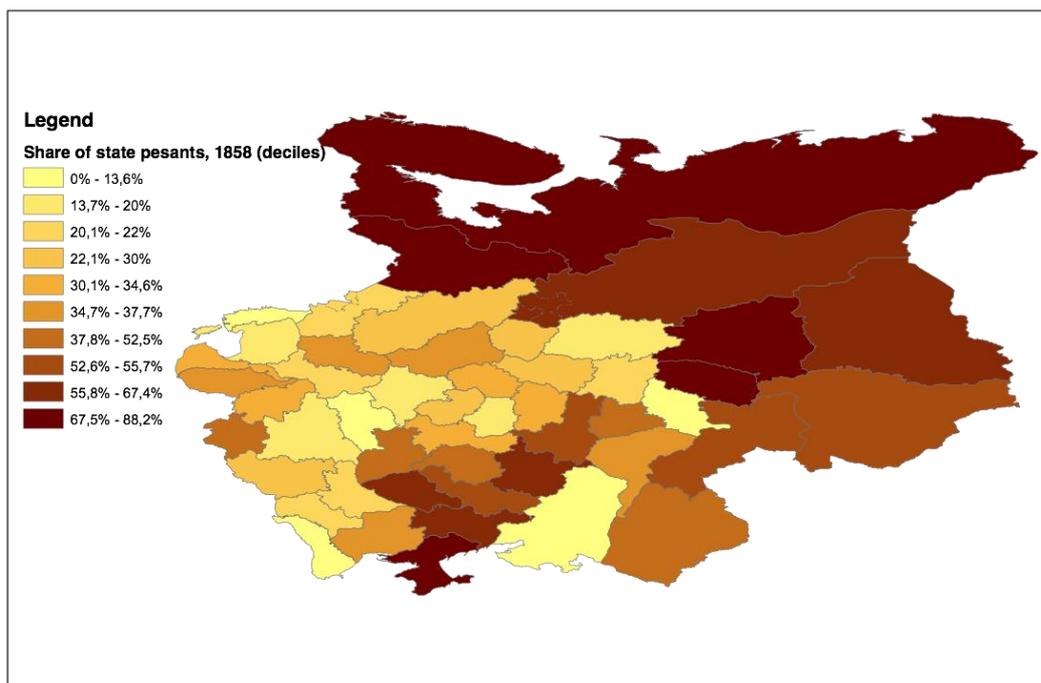
Panel B. Free agricultural workers in 1858 as a share of rural population

Legend
Share of free agricultural workers, 1858 (deciles)
- 3,7% - 3,9%
- 4% - 4,2%
- 4,3% - 4,4%
- 4,5% - 5,1%
- 5,2% - 5,4%
- 5,5% - 8,1%
- 8,2% - 10%
- 10,1% - 13,9%
- 14% - 55,7%
- 55,8% - 98,5%
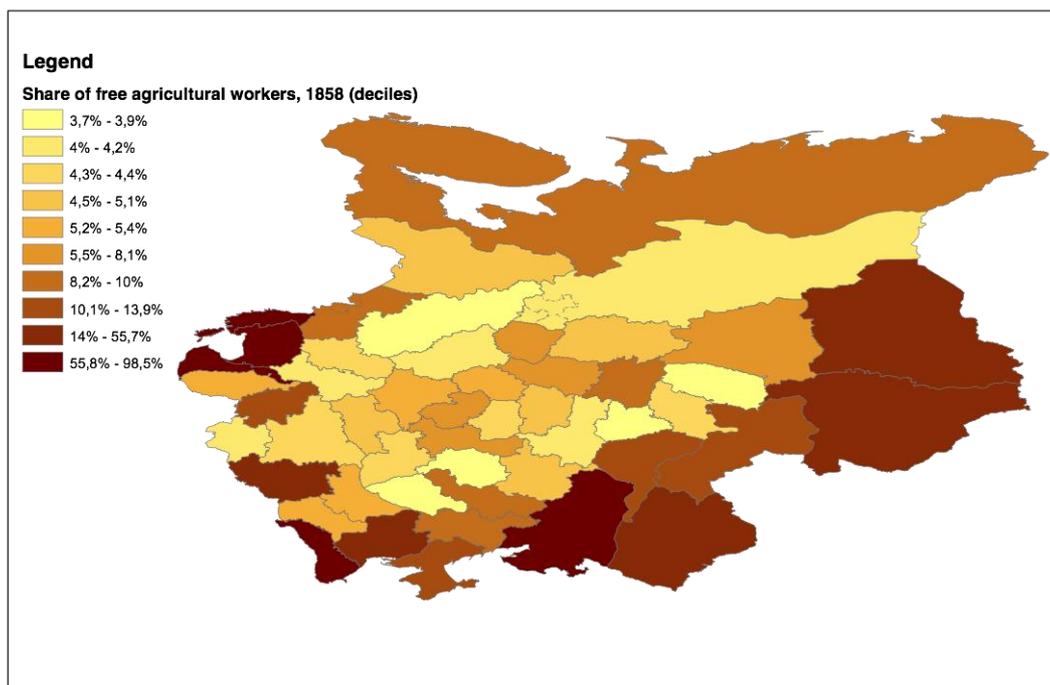
Notes: Equirectangular projection used.

Figure A4. Illustration of the first-stage relationship at district level
Panel A. Full sample

Scatter plot conditional on log distance from Moscow
Full sample

Share of serfs in 1858 by district

Share of monasterial serfs before nationalization by district

coef = -.63157085, (robust) se = .08611091, t = -7.33
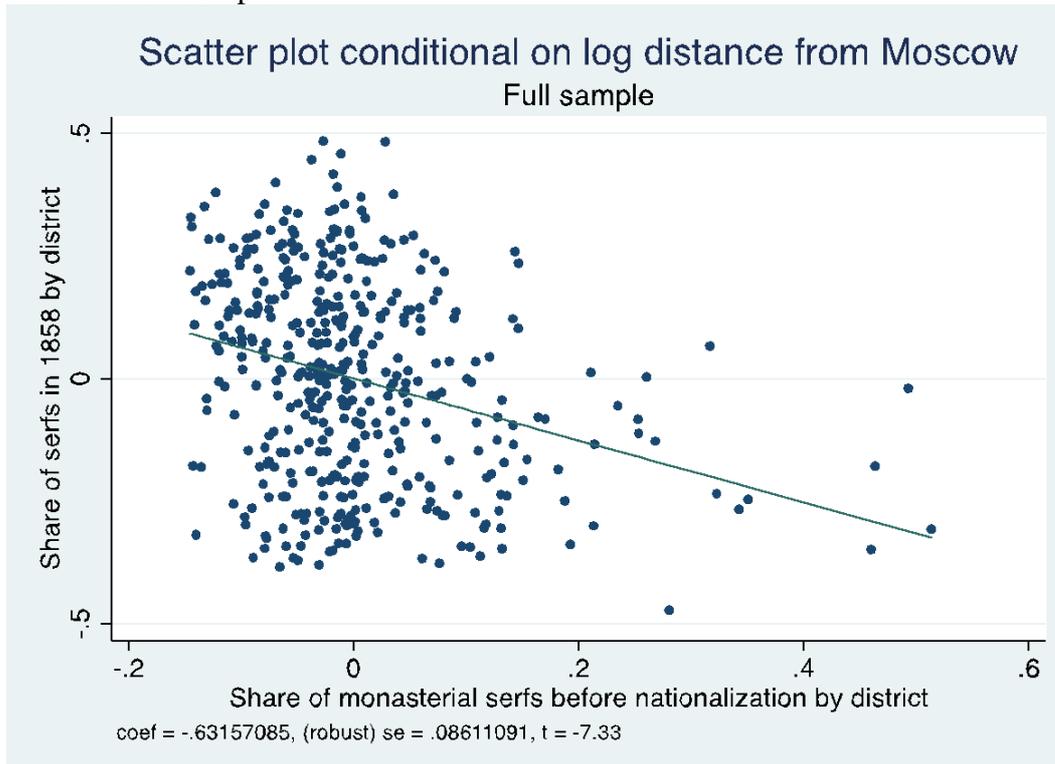
Panel B. Sample restricted to districts with the share of nationalized monasterial serfs below 0.3.

Scatter plot conditional on log distance from Moscow
Subsample of districts with the share of monasterial serfs < 0.3

Share of serfs in 1858 by district

Share of monasterial serfs before nationalization by district

coef = -.66552928, (robust) se = .15324494, t = -4.34
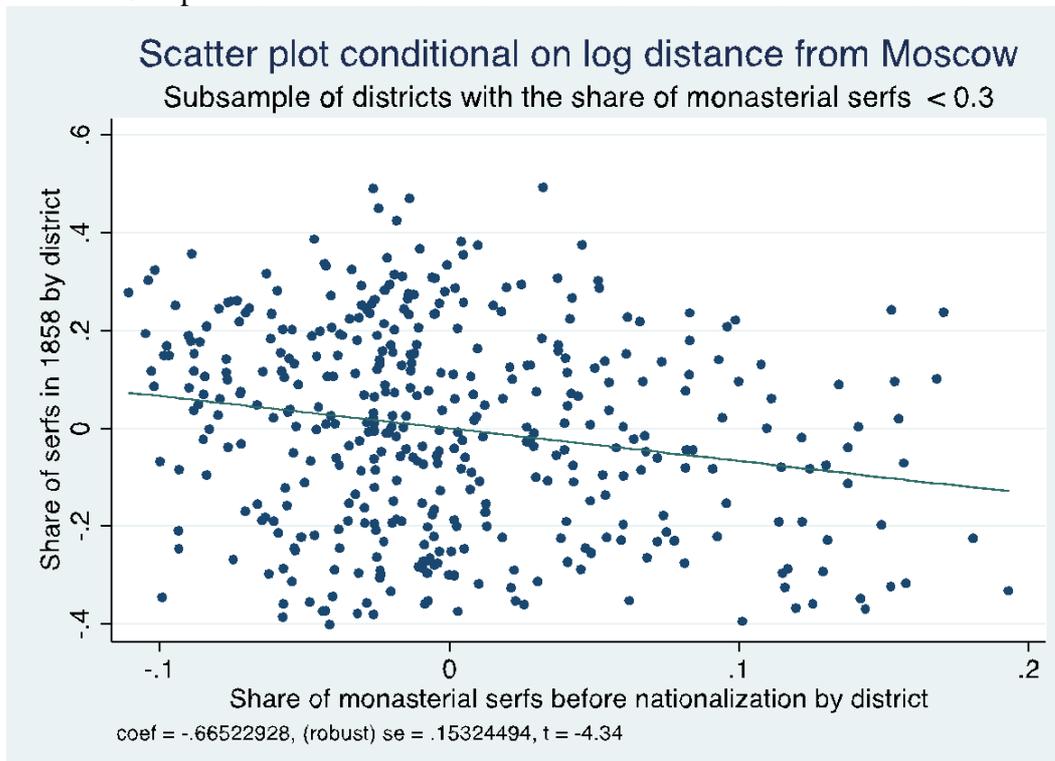
Figure A5. Illustration of the relationship between gentry indebtedness and grain productivity.
Panel A. Gentry indebtedness in 1858 and grain productivity in 1858.
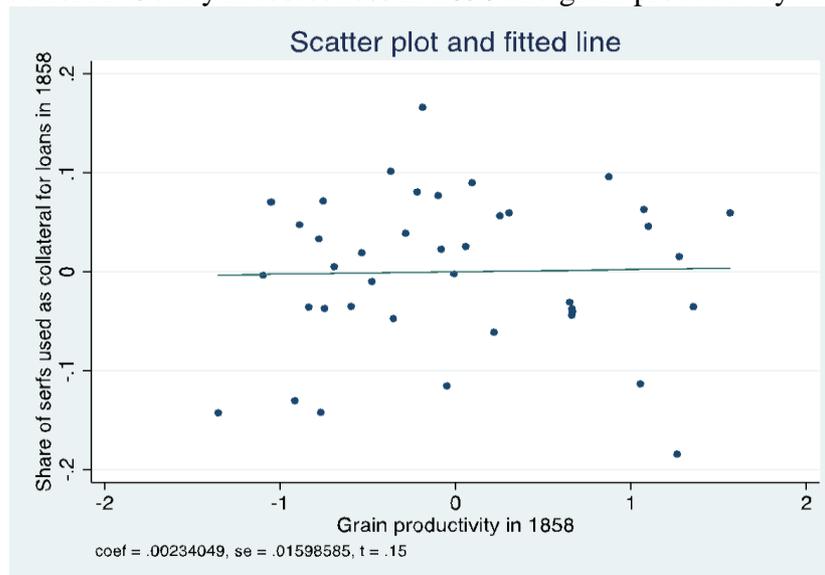
Panel B. Gentry indebtedness in 1858 and changes in grain productivity between 1858 and 1853.
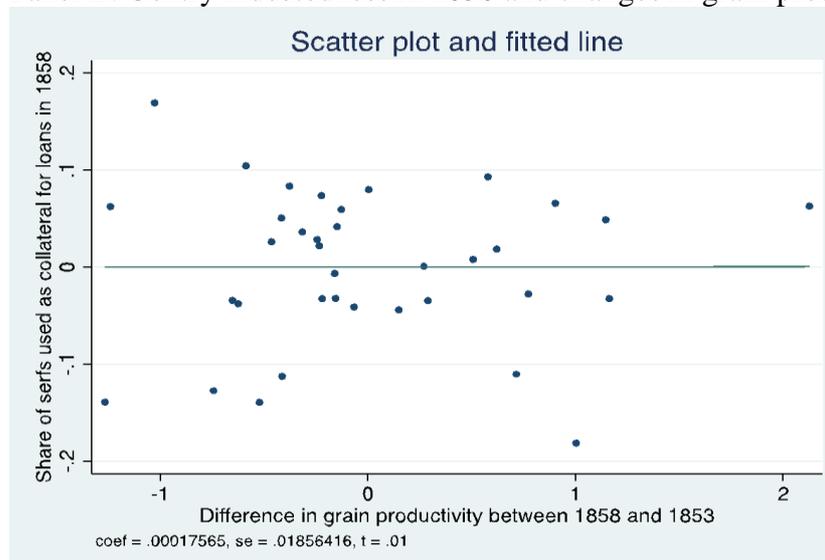
Panel C. Gentry indebtedness in 1858 and the share of serfs on corvee in 1858
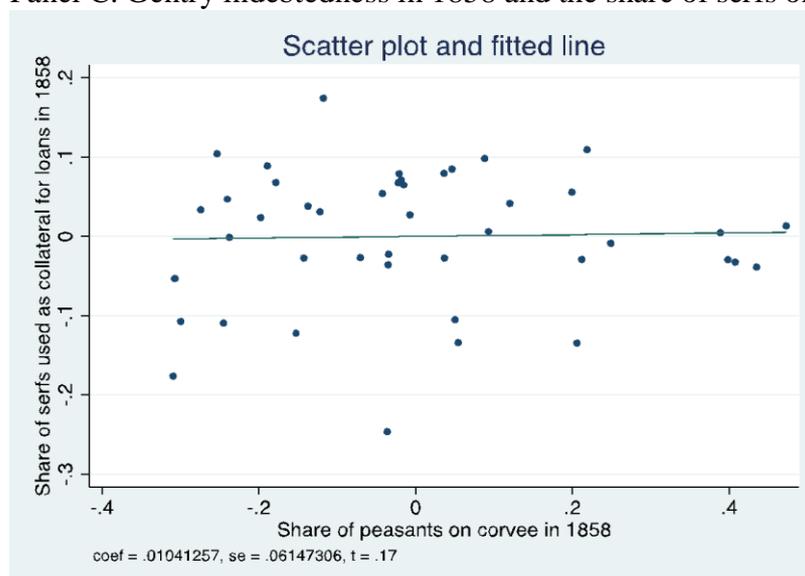
Figure A6. Cross-sectional relationship between prevalence of serfdom and the growth in grain productivity between before and after the emancipation
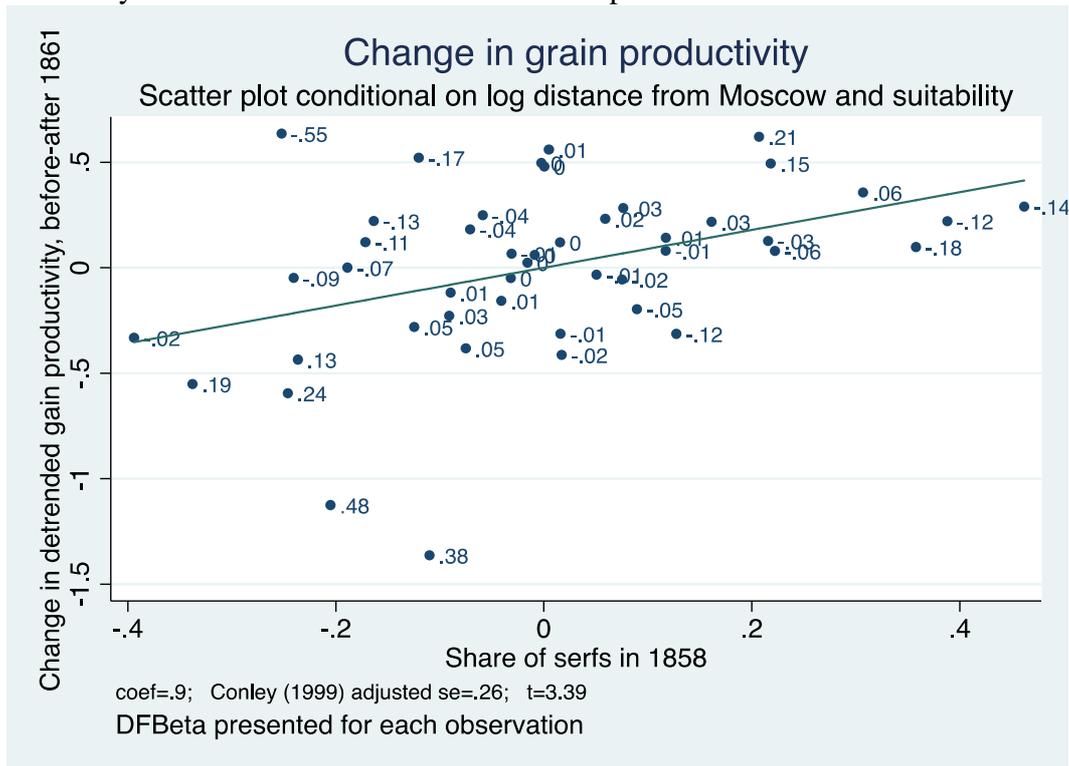
Figure A7. **Industrial output and the share of serfs pre- and post-emancipation**
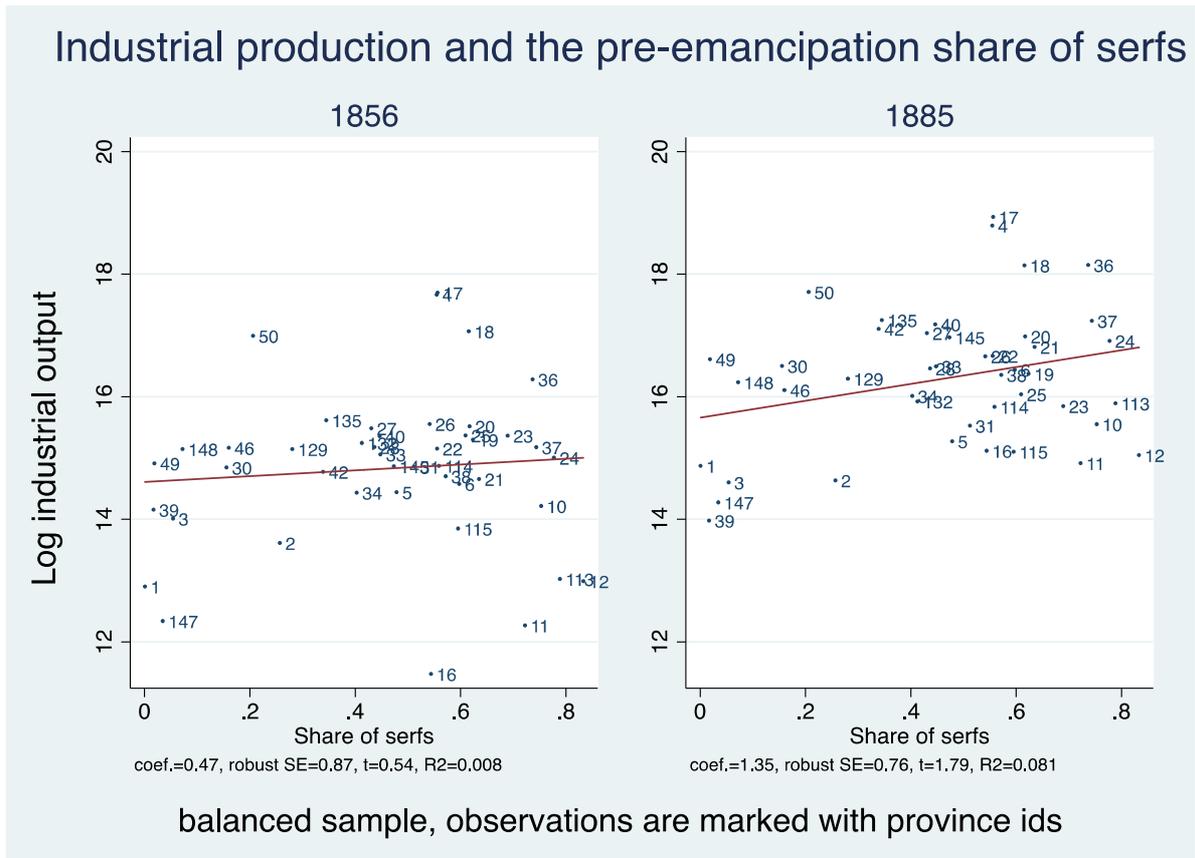
Notes: The figure presents unconditional scatter plots among with the linear fit between log industrial output and the share of serfs across provinces on the same sample at two points in time: 1856 and 1885.

Figure A8. Cross-sectional relationship between prevalence of serfdom and the growth in industrial output between before and after the emancipation

Figure A9. **The time-varying effect of emancipation: draftees' height (district-level).**
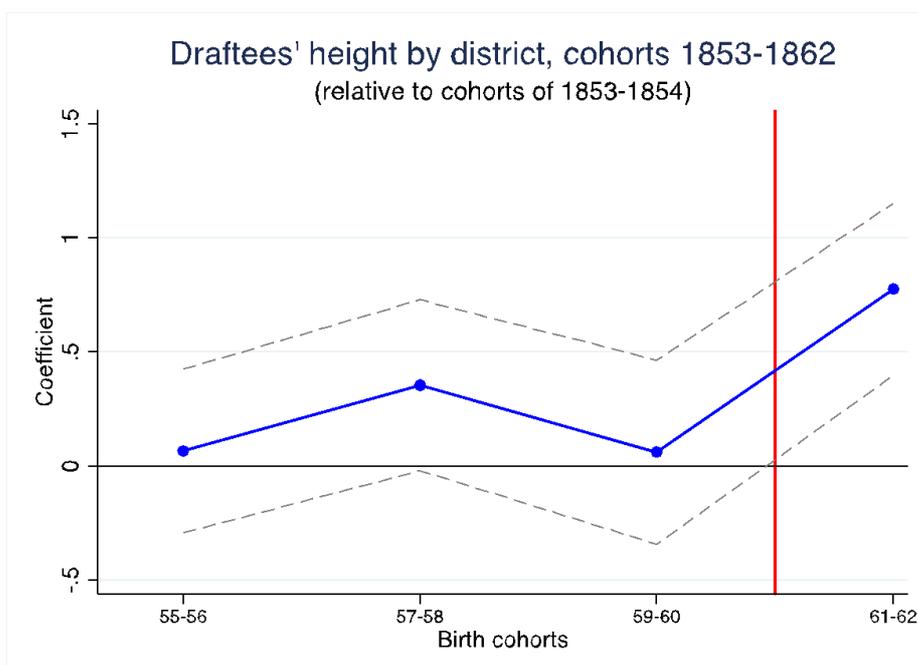
Notes: The figure presents coefficients (along with their 90% confidence interval) in the regression of the height of draftees on 2-year interval dummies for birth cohorts born around the emancipation interacted with the share of serfs in a district, district and birth-cohort fixed effects, and controls for demeaned suitability interacted with the post-emancipation dummy, and demeaned distance from Moscow interacted with the post-emancipation dummy. Two cohorts of 1853 and 1854 are held as the comparison group. The vertical red line marks the timing of the emancipation. The table-form representation of the results of this estimation is presented in column 4 of Table A3 in the online appendix.

Figure A10. Cross-sectional relationship between prevalence of serfdom and the growth in height of draftees between before and after the emancipation

Panel A. Province-level data
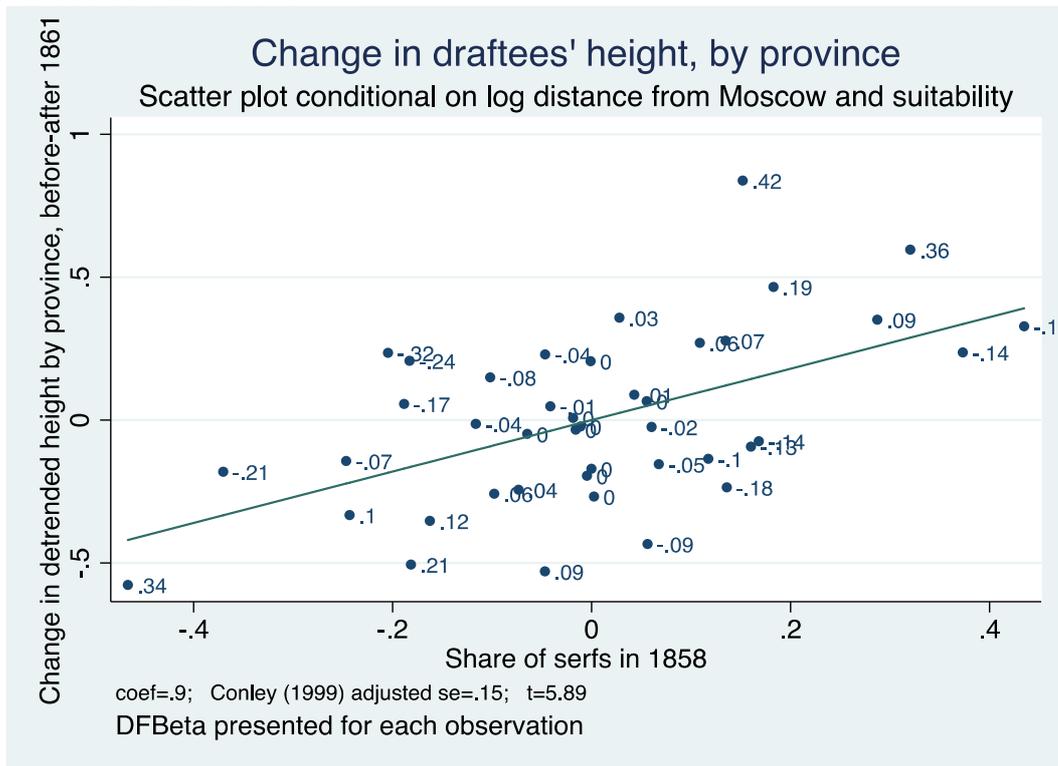
Panel B. District-level data
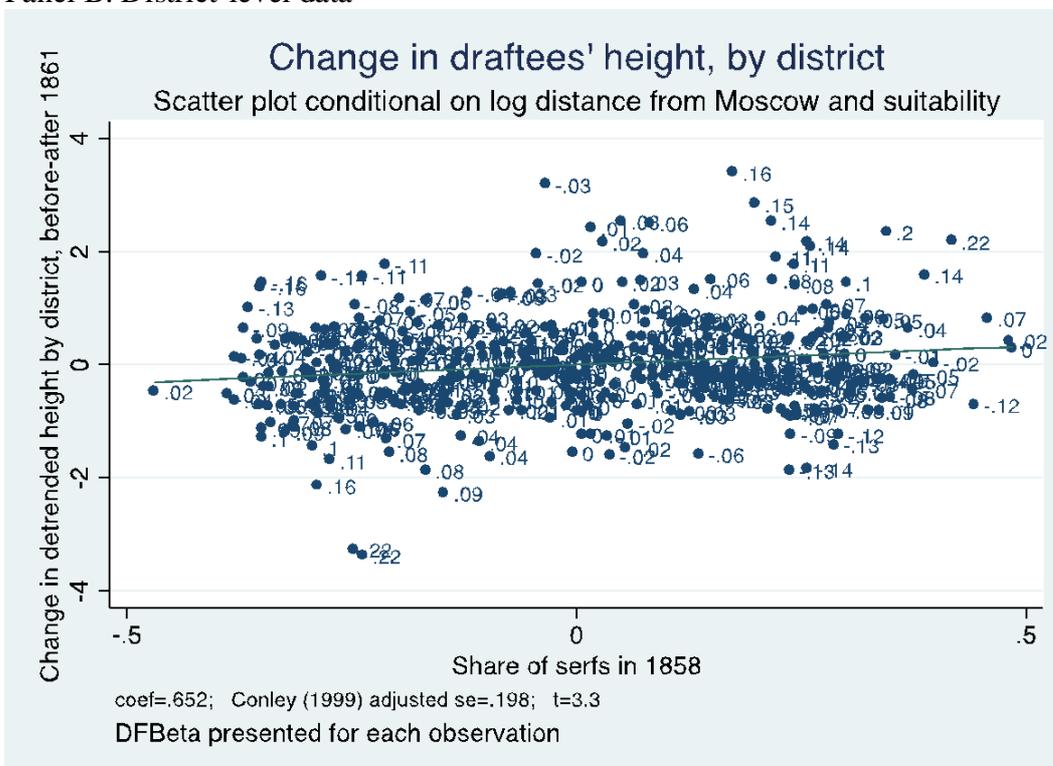
Figure A11. Placebo dates for the emancipation reform
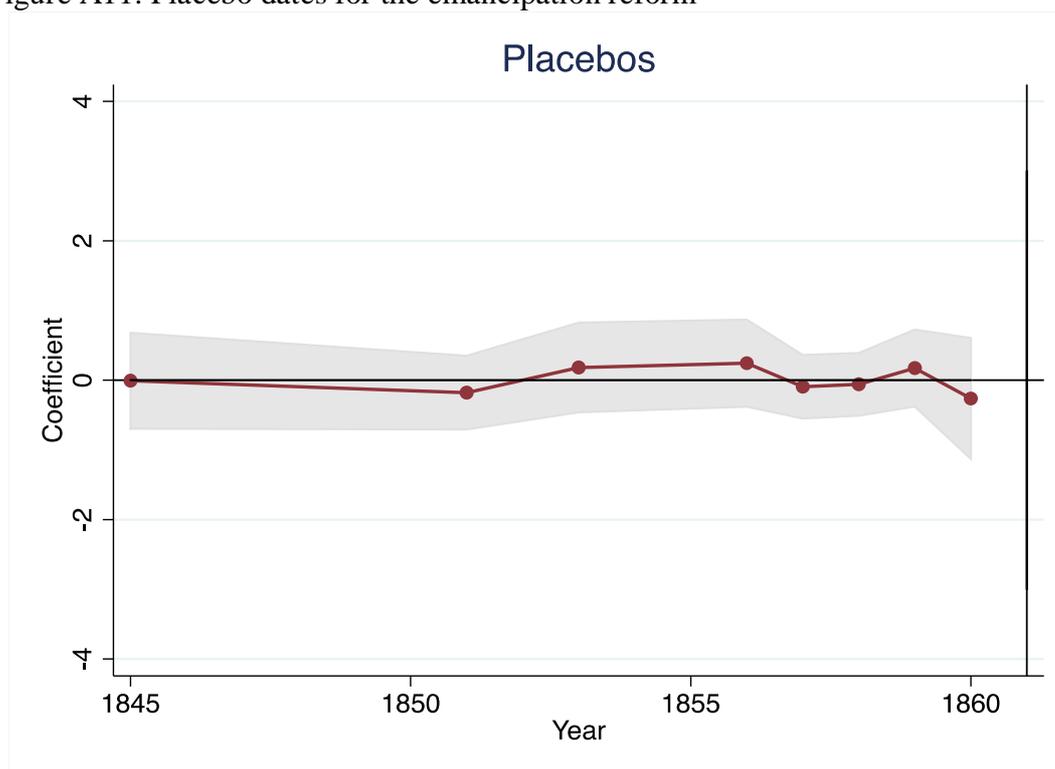
Notes: The figure reports the β^T coefficients along with their 95% confidence intervals against year T from a series of regressions of the following form on the sample of years before 1861:

$$Y_{it} = \beta^T \, ShareSerfs_i \times Post\text{-}T_t + \mathbf{X^T_{it}}'\gamma + \psi_i + \sigma_t + \varepsilon_{it},$$

where *Post-T$_t$* is a dummy, which switches on in year T and $\mathbf{X^T_{it}}$ is a vector comprised of the interactions of the log distance from Moscow and of land suitability with the *Post-T$_t$* dummy. ψ_i and σ_t are the province and year fixed effects.

Appendix Tables

Table A1. Data sources and time span of the data

Variable:	Years:	Source:
Grain productivity	1795	Rubinshtein (1957), Kessler and Markevich (2015)
	1800s-1820s, 1840s by decade	Koval'chenko (1959)
	1851, 1856	Commission … (1873)
	1852-1855, averages for 4 years[A1]	Commission … (1873), Kessler and Markevich (2015), Koval'chenko (1959), Vilson (1869)
	1857, 1859-1863 by year	Vilson (1869)
	1858	Kessler and Markevich (2015)
	1864-1866 by year	Obruchev (1871)
	1870-1876 by year	Materialy … (1880)
	1883-1887 by year	TsSK MVD (1888)
	1888-1900 by year	Urozhaj v … (1889-1901)
Height of draftees	1853-1862 by year	Vseobshchaya … (1886)
	1863-1864 by year	Sbornik … (1887)
	1865-1866 by year	Sbornik … (1890)
Industrial output	1796	Kessler and Markevich (2015)
	1849	Statisticheckie … (1852)
	1856	Statisticheckie … (1858)
	1858	Kessler and Markevich (2015)
	1882, 1883	Sbornik … (1884)
	1885	Statisticheckii … (1887)
	1897	Kessler and Markevich (2015)
Winter and spring grain seeds planted for the harvest of the corresponding year	1849	Statisticheckie … (1852)
	1851, 1856, 1861, 1871	Commission … (1873)
	1858	Kessler and Markevich (2015)
	1864-1866 by year	Obruchev (1871)
	1883, 1893-1900 by year	Urozhaj v … (1889-1901)

[A1] Estimated from averages for the decade of the 1850s (Koval'chenko 1959) and annual figures for 1851, 1856 (Commission … 1873), 1857, 1859, 1860 (Vilson 1869) and 1858 (Kessler, Markevich 2015).

…Continued from the previous page.

World prices of rye and wheat (Nethelands)	1800-1900 by year	van Reil (2016)
Russian prices of rye and oat (by region)	1800-1900 by year	Mironov (1985)
Cultivated land	1800, 1858	Kessler and Markevich (2015)
	1871, 1877	Statistika … (1880-1886)
Distribution of rural population by status: serfs, state, royal peasants, and free agricultural workers	1858 1857	Bushen (1863), Troinitskii (1861) Kabuzan (1971)
Redemption payments	1862-1876 by year	Vilson (1878)
Monasterial and clergy serfs	1796 and 1814	Beskrovnii et al. (1972)
Gentry debts and mortgages	1858	Skrebitskii (1862-1866)
Signed and unsigned regulatory charters	1863	Vilson (1878)
Land cuts (in percentage to peasants land before the emancipation)	1863	Zajonchkovskii (1960)
Re-partition commune dummy	1905	Durbrovskii (1963)
Zemstvo expenditures	Averages for 1868, 1871, 1876, 1880, 1885, 1890, 1895, 1903	Veselovskii (1909)
Court reform	1864-1896 by year	Ministry of Justice (1902)
Railways density	1795-1900 by year	Sollogub (1874), Sbornik … (1884), Kessler and Markevich (2015)
Crop suitability	Modern day; under the assumption of rain-fed low-input agriculture for the main crops grown in the area	GAEZ Portal: http://www.gaez.iiasa.ac.at/
Temperature	1795-1900 by year	The Global Land Surface Databank (Rennie et al., 2014)

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Table A2. Data availability and agricultural productivity.

	(1)	(2)	(3)	(4)	(5)	(6)
	Dummy on availability of annual X-sections on grain productivity (0=no data; 1=data available)			Dummy on availability of annual X-sections on industrial output (0=no data; 1=data available)		
Detrended grain productivity (national level), quadratic fit	0.022 [0.086]	0.054 [0.127]	0.054 [0.129]	-0.033 [0.052]	0.044 [0.059]	0.044 [0.057]
Detrended grain productivity (national level), quadratic fit X Post-emancipation		-0.071 [0.169]	-0.074 [0.173]		-0.17 [0.105]	-0.17 [0.103]
Time trend			-0.0008 [0.001]			0.0018** [0.001]
Constant	0.81*** [0.040]	0.81*** [0.040]	2.31 [2.062]	0.070*** [0.026]	0.067*** [0.024]	-3.31** [1.439]
Observations	100	100	100	100	100	100
R-squared	0.001	0.003	0.006	0.004	0.030	0.073

Notes: Post-emancipation is a dummy, which is switched on in 1861.

*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A3. Dynamics of the results of the abolition of serfdom

Dependent var: Grain productivity		Dependent var: log industrial output		Dependent var: Draftees' height		Dependent var: Draftees' height	
Sample:	provinces	Sample:	provinces	Sample:	provinces	Sample:	districts
Share of serfs X (years 1840s)	0.01 [0.473]	Share of serfs X (year 1849)	0.68 [0.759]	Share of serfs X (cohorts 1855-1856)	0.27 [0.293]	Share of serfs X (cohorts 1855-1856)	0.07 [0.219]
Share of serfs X (years 1850-1855)	-0.51 [0.530]	Share of serfs X (years 1856, 1858)	0.80 [0.831]	Share of serfs X (cohorts 1857-1858)	0.47* [0.267]	Share of serfs X (cohorts 1857-1858)	0.35 [0.229]
Share of serfs X (years 1856-1860)	-0.17 [0.504]	Share of serfs X (years 1882, 1883)	2.51*** [0.762]	Share of serfs X (cohorts 1859-1860)	0.30 [0.341]	Share of serfs X (cohorts 1859-1860)	0.06 [0.246]
Share of serfs X (years 1861-1865)	0.67 [0.476]	Share of serfs X (year 1885)	2.70*** [0.768]	Share of serfs X (cohorts 1861-1862)	0.95*** [0.269]	Share of serfs X (cohorts 1861-1862)	0.776*** [0.230]
Share of serfs X (years 1866-1870)	0.66 [0.577]	Share of serfs X (year 1897)	2.17** [0.901]	Share of serfs X (cohorts 1863-1864)	1.20*** [0.253]	Dmnd log distance from Moscow X Post-emancipation	0.18*** [0.0560]
Share of serfs X (years 1871-1875)	1.36** [0.560]	Dmnd log distance from Moscow X Post-emancipation	0.34 [0.459]	Share of serfs X (cohorts 1865-1866)	1.40*** [0.320]	Dmnd crop suitability X Post-emancipation	0.08*** [0.0242]
Share of serfs X (years 1876-1880)	1.98*** [0.722]	Dmnd crop suitability X Post-emancipation	0.10 [0.061]	Dmnd log distance from Moscow X Post-emancipation	0.73*** [0.178]		
Share of serfs X (years 1881-1885)	0.77 [0.668]			Dmnd crop suitability X Post-emancipation	0.15*** [0.022]		
Share of serfs X (years 1886-1890)	1.28** [0.605]						
Share of serfs X (years 1891-1895)	0.58 [0.663]						
Share of serfs X (years post 1895)	1.14* [0.663]						
Dmnd log distance from Moscow X Post-emancipation	-0.66* [0.333]						
Dmnd crop suitability X Post-emancipation	0.07* [0.044]						
Share of state peasants X Post-1866	Yes	Share of state peasants X Post-1866	Yes	Share of state peasants X Post-1866	No	Share of state peasants X Post-1866	No
Share of royal peasants X Post-1859	Yes	Share of royal peasants X Post-1859	Yes	Share of royal peasants X Post-1859	No	Share of royal peasants X Post-1859	No
Province and year FEs	Yes	Province and year FEs	Yes	Province and year FEs	Yes	Province and year FEs	Yes
Region-specific trends	Yes	Region-specific trends	Yes	Region-specific trends	No	Region-specific trends	No
Observations	1,831	Observations	343	Observations	584	Observations	4,437
R-squared	0.390	R-squared	0.892	R-squared	0.228	R-squared	0.732
Comparison X-sections	1795-1829	Comparison X-sections	1795	Comparison X-sections	1853-1854	Comparison X-sections	1853-1854

Notes: Standard errors are clustered by province or by district separately before and after 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.
*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A4. The effect of the abolition of serfdom on productivity in agriculture differentially depending on the distance from Moscow

	(1)	(2)
Dependent var:	Grain productivity	
Model:	OLS	OLS
Share of serfs X	1.11***	1.33***
Post-emancipation	[0.227]	[0.225]
Share of serfs X Demeaned log distance	-1.07*	-1.02*
from Moscow X Post-emancipation	[0.607]	[0.605]
Demeaned crop suitability X	0.06	0.05
Post-emancipation	[0.040]	[0.038]
Year and province fixed effects	Yes	Yes
Province-specific trends	Yes	Yes
Share of state peasants X Post-1866	No	Yes
Share of royal peasants X Post-1859	No	Yes
Observations	1,835	1,835
R-squared	0.402	0.403

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.
 *** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A5. Robustness to using WLS by log grain output: the effects of the abolition of serfdom on productivity in agriculture

Panel A: Panel data estimation

Dependent var: Model:	(1) WLS	(2) WLS	(3) weighted IV, 2nd stage	(4) WLS	(5) Grain productivity	(6) WLS	(7) weighted IV, 2nd stage
Share of serfs X Post-emancipation	0.79*** [0.252]	0.87** [0.431]	1.44** [0.731]	1.38*** [0.498]		2.13*** [0.581]	3.17*** [1.082]
Share of serfs X 1861-1870					0.80* [0.417]		
Share of serfs X 1871-1900					1.18** [0.509]		
Share of peasants with signed buyout contracts						-1.09*** [0.325]	-1.11*** [0.368]
Demeaned log distance to Moscow X Post-emancipation		-1.42** [0.589]	-1.02 [0.733]	-1.24** [0.598]	-1.42** [0.585]	-0.31 [0.590]	0.35 [0.853]
Demeaned crop suitability X Post-emancipation		0.21*** [0.074]	0.19*** [0.072]	0.19** [0.074]	0.21*** [0.073]	0.21*** [0.078]	0.18** [0.077]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes	Yes
State and royal peasant reforms	No	No	No	Yes	No	No	No
Observations	1,443	1,443	1,443	1,443	1,443	1,403	1,403
R-squared	0.512	0.535	0.535	0.536	0.535	0.543	0.543

Panel B: First stages of the corresponding 2SLS panel regressions

Dependent var: Model:	(3) Share of serfs X Post-emancipation weighted IV, 1st stage	(7.1) Share of serfs X Post-emancipation weighted IV, 1st stage	(7.2) Share of peasants with signed buyout weighted IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation	-1.29*** [0.303]	-1.30*** [0.308]	-1.66*** [0.364]
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882		0.14 [0.156]	2.95*** [0.185]
Controls as in respective column of Panel A	Yes	Yes	Yes
Observations	1,443	1,403	1,403
F, monasterial serfs instrument	18.22	17.86	20.89
F, indebtedness instrument		0.760	252.9

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861. 1861-1870 and 1871-1900 time dummies equal to 1 in corresponding years and 0 otherwise. Share of peasants with signed buyout contracts equals 0 in all provinces for the years before 1862 and then gradually reaches the share of serfs in the corresponding province. In the non-western provinces this happened by 1882, and in western provinces there is a discrete jump in this variable to the share of serfs in 1863. Indebtedness is the ratio of serfs in the province used as collateral in landlords' debt contracts in 1858 to the total rural population in the province

*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A6. The effect of the abolition of serfdom on cultivated lands

Dependent var:	(1) Ln (cultivated land)	(2) Share of serfs X Post-emancipation	(3) Ln (cultivated land)	(4) Ln (cultivated land)
	OLS	IV, 1st stage	IV, 2nd stage	OLS
Share of serfs X Post-emancipation	-0.16 [0.203]		0.23 [0.347]	0.70 [0.994]
Share of nationalized monasterial serfs X Post-emancipation		-1.05*** [0.312]		
Demeaned log distance from Moscow X Post-emancipation	0.37* [0.197]	-0.94*** [0.103]	0.66** [0.259]	0.49** [0.192]
Demeaned crop suitability X Post-emancipation	0.02 [0.032]	0.03* [0.019]	0.02 [0.029]	0.03 [0.034]
Share of state peasants X Post-1866	No	No	No	Yes
Share of royal peasants X Post-1859	No	No	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes
Region-specific trends	Yes	Yes	Yes	Yes
Observations	191	191	191	191
F, monasterial serfs instrument		11.38		
R-squared	0.381	0.964	0.947	0.385

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.

 *** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A7. Robustness of the effect of the abolition of serfdom on height of draftees at district level: samples excluding Moscow and Saint Petersburg districts.

Panel A: Panel data estimation

	(1)	(2)	(3)
Dependent var:	Draftees' height (cohorts 1853-1862)		
Data set:	District-level data		
Sample:	Without Moscow and St.Petersburg		
Model:	OLS	OLS	IV, 2nd stage
Share of serfs X Post-emancipation cohorts	0.42***	0.66***	0.81*
	[0.141]	[0.156]	[0.485]
Demeaned log distance from Moscow X Post-emancipation		0.18***	0.21**
		[0.053]	[0.095]
Demeaned crop suitability X Post-emancipation		0.08***	0.08***
		[0.023]	[0.025]
Birth cohort and province or district fixed effects	Yes	Yes	Yes
Province-specific trends	No	No	No
Observations	4,427	4,427	4,347
R-squared	0.559	0.561	0.730

Panel B: First stages of the corresponding 2SLS panel regressions

	(2) Share of serfs X Post-emancipation cohorts
Dependent var:	
Model:	IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation cohorts	-0.65***
	[0.074]
Controls as in respective column of Panel A	Yes
Observations	4,347
F, excluded instrument	76.09

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.

*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A8. Chest of orthodox males measured in the age of 21 in Bobruisk district (cohorts 1853-1878) by height groups

Chest of ortodox males measured in the age of 21 in Borujsk district (cohorts 1853-1878) by height groups

Height (centimeters)	Chest size (centimeters)		N of males
	Min	Max	
Height: 153.4 -155.6	72.8	94.5	612
Height: 155.6 -160	71.1	95	3570
Height: 160 - 164.5	75.6	98.3	4929
Height: 164.5 -168.9	72.2	98.3	5318
Height: 168.9 -173.4	76.7	100	3440
Height: 173.4 -177.8	78.9	101.1	1377
Height: 177.8 -182.2	80.6	102.2	312
Height: 182.2 -186.7	77.2	97.8	48
Height: 186.7 - 188.9	85.6	92.8	4

Source: Gorskii P.A. (1910). K kharakteristike phizicheskogo razvitiya naseleniya Bobrujskogo yezda Minskoj gubernii. Po dannim prizyvnykh spiskov voinskogo prisutstviya za 1874-1899. Dissertatsiya na stepen doktora meditcyny. [On characteristics of physical anthropology of citizens of Borujsk district of Minsk province. Based on conscription lists of the district conscription commission, 1874-1899. Ph. D. dessirtation in medicine]. Saint-Peterburg: Trej. Appendix. Table VIII.

Table A9. Draft reforms of chest-to-height minimum, the geography of serfdom and draftees' height

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent var:	Draftees' height			Unadjusted draftees height		
Sample:	Cohorts born in 1861-1863	Cohorts born in 1862-1866	Cohorts born in 1861, 1864-1866	Cohorts born in 1861-1863	Cohorts born in 1862-1866	Cohorts born in 1861, 1864-1866
Model:	OLS	OLS	OLS	OLS	OLS	OLS
Share of serfs X Post-1862	0.10 [0.278]			0.12 [0.257]		
Share of serfs X Post-1864		0.57 [0.376]	0.59 [0.458]		0.56 [0.363]	0.61 [0.442]
Demeaned Log Distance from Moscow and suitability interacted with the respective placebo reform	Yes	Yes	Yes	Yes	Yes	Yes
Birth cohort and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	No	No	No	No	No
Observations	126	168	168	126	168	168
R-squared	0.223	0.192	0.275	0.323	0.306	0.461

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861. The 1883 reform of chest-to-height minimum affected cohorts born in 1862 and 1863. The 1885 reform of chest-to-height minimum affected cohorts born in 1864 and latter.

 *** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1

Table A10. The abolition of serfdom and peasant living standards: draftees' height (original figures, non-adjusted for 1882 reform of chest-to-height minimum which affected the cohort born in 1861)

Panel A: Panel data estimation

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent var:	Unadjusted draftees' height (cohorts 1853-1866)			Unadjusted draftees' height (cohorts 1853-1862)		
Data set:	Province-level data			District-level data		
Model:		OLS	IV, 2nd stage		OLS	IV, 2nd stage
Share of serfs X	0.76***	0.91***	0.76**	0.41***	0.61***	0.89*
Post-emancipation cohorts	[0.155]	[0.127]	[0.309]	[0.128]	[0.143]	[0.459]
Demeaned log distance from Moscow X		0.69***	0.60***		0.14***	0.19**
Post-emancipation		[0.170]	[0.230]		[0.049]	[0.089]
Demeaned crop suitability X		0.15***	0.16***		0.08***	0.09***
Post-emancipation		[0.021]	[0.022]		[0.021]	[0.023]
Birth cohort and province or district fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	No	No	No	No	No
Observations	584	584	584	4,437	4,437	4,357
R-squared	0.199	0.291	0.857	0.592	0.594	0.591
F, excluded instrument			17.32			72.12

Panel B: Exactly the same as in Table 5

Panel C: Cross-sectional estimation robust to spatial correlation

	(1)	(2)	(3)	(4)
Dependent var:	The change in detrended height by province b/w pre- and post-emancipation cohorts		The change in detrended height by district b/w pre- and post-emancipation cohorts	
Model:	OLS spatial HAC		OLS spatial HAC	
Sample:	full	|DFBeta|<0.3	full	|DFBeta|<0.15
Share of serfs	0.89***	0.65***	0.61***	0.43***
	[0.154]	[0.132]	[0.196]	[0.133]
Log distance from Moscow, crop suitability	Yes	Yes	Yes	Yes
Observations	42	39	447	438
Adj R-squared	0.554	0.511	0.047	0.046

Notes: In Panel A standard errors are clustered by province separately before and after the 1861 emancipation reform. In Panel C, standard errors are adjusted to spatial correlation within 900 km. Post-emancipation is a dummy, which is switched on in 1861.

*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1

Table A11. Controlling for potentially confounding factors in the estimation of the effect of the abolition of serfdom on grain productivity

Dependent var:	(1)	(2)	(3)	(4)	(5)
			Grain productivity		
	OLS	OLS	OLS	OLS	OLS
Share of serfs X Post-emancipation	0.83***	0.88***	1.05***	0.90***	0.54*
	[0.259]	[0.258]	[0.262]	[0.281]	[0.290]
Ln(railways)	0.037**				0.038**
	[0.014]				[0.016]
Temperature		-0.16**			-0.17***
		[0.061]			[0.064]
Court reform			0.050		0.11
			[0.160]		[0.154]
Zemstvo expenditures per capita in 1868-1903 X Post-1864				-0.15	-0.20
				[0.115]	[0.121]
Demeaned log distance from Moscow X Post-emancipation	-0.83**	-0.84**	-0.82**	-1.01***	-0.85**
	[0.383]	[0.368]	[0.377]	[0.373]	[0.408]
Demeaned crop suitability X Post-emancipation	0.01	0.01	0.06	0.05	-0.05
	[0.040]	[0.037]	[0.040]	[0.036]	[0.039]
Share of state peasants X Post-1866	Yes	Yes	Yes	Yes	Yes
Share of royal peasants X Post-1859	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes
Observations	1,794	1,775	1,835	1,835	1,734
R-squared	0.411	0.411	0.404	0.404	0.420

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.
 *** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A12. Controlling for potentially confounding factors in the estimation of the effect of the abolition of serfdom on industrial output

Dependent var:	(1)	(2)	(3)	(4)	(5)
	Ln (industrial output)				
	OLS	OLS	OLS	OLS	OLS
Share of serfs X Post-emancipation	1.38** [0.573]	1.49*** [0.345]	1.37** [0.576]	0.58 [0.553]	0.52 [0.460]
Ln(railways)	0.00014 [0.024]				-0.029 [0.023]
Temperature		0.029 [0.040]			0.057 [0.038]
Court reform			0.025 [0.119]		0.11 [0.137]
Zemstvo expenditures per capita in 1868-1903 X Post-1864				-0.45*** [0.110]	-0.49*** [0.112]
Demeaned log distance from Moscow X Post-emancipation	0.52 [0.449]	0.48 [0.515]	0.53 [0.446]	-0.09 [0.468]	-0.14 [0.516]
Demeaned crop suitability X Post-emancipation	0.12* [0.066]	0.06 [0.067]	0.13* [0.065]	0.11* [0.061]	0.05 [0.065]
Share of state peasants X Post-1866	Yes	Yes	Yes	Yes	Yes
Share of royal peasants X Post-1859	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Region-specific trends	Yes	Yes	Yes	Yes	Yes
Observations	347	308	347	347	308
R-squared	0.887	0.873	0.887	0.893	0.882

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.

*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A13. Controlling for potentially confounding factors in the estimation of the effect of the abolition of serfdom on the height of draftees

Dependent var:	(1)	(2)	(3)	(4)	(5)
	Draftees' height (cohorts 1853-1866)				
	OLS	OLS	OLS	OLS	OLS
Share of serfs X Post-emancipation	0.91*** [0.125]	0.89*** [0.127]	0.92*** [0.130]	0.78*** [0.147]	0.72*** [0.143]
Ln(railways)	0.01 [0.016]				0.01 [0.016]
Temperature		0.03 [0.032]			0.03 [0.031]
Court reform			0.05 [0.109]		0.07 [0.112]
Zemstvo expenditures per capita in 1868-1903 X Post-1864				-0.12 [0.086]	-0.13 [0.086]
Demeaned log distance from Moscow X Post-emancipation	0.74*** [0.183]	0.67*** [0.181]	0.75*** [0.180]	0.65*** [0.186]	0.60*** [0.200]
Demeaned crop suitability X Post-emancipation	0.15*** [0.021]	0.15*** [0.022]	0.15*** [0.022]	0.15*** [0.022]	0.15*** [0.022]
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	No	No	No	No
Observations	584	579	584	584	579
R-squared	0.218	0.204	0.217	0.224	0.213

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.
*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A14. Re-estimation of Table 2 in the subsample excluding the provinces of the former Polish-Lithuanian Commonwealth before 1843, i.e., before the year of nationalization of lands with catholic monasteries

Panel A: Panel data estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent var:				Grain productivity			
Sample:			Excluding the provinces of the former Polish-Lithuanian Commonwealth before 1843				
Model:	OLS	OLS	IV, 2nd stage	OLS		OLS	IV, 2nd stage
Share of serfs X Post-emancipation	0.84*** [0.230]	0.72*** [0.218]	1.25** [0.457]	0.97*** [0.219]		0.87*** [0.330]	2.69*** [0.633]
Share of serfs X 1861-1870					0.69*** [0.213]		
Share of serfs X 1871-1900					0.84** [0.371]		
Share of peasants with signed buyout contracts						-0.33 [0.257]	-1.15*** [0.333]
Demeaned log distance from Moscow X Post-emancipation		-1.03*** [0.336]	-0.64 [0.422]	-0.97*** [0.333]	-1.02*** [0.337]	-0.78* [0.406]	0.53 [0.495]
Demeaned crop suitability X Post-emancipation		0.07* [0.040]	0.06 [0.043]	0.06 [0.038]	0.07* [0.040]	0.07* [0.039]	0.06 [0.047]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes	Yes
State and royal peasant reforms	No	No	No	Yes	No	No	No
Observations	1,828	1,828	1,828	1,828	1,828	1,773	1,773
R-squared	0.368	0.404	0.533	0.405	0.404	0.404	0.539

Panel B: First stages of the corresponding 2SLS panel regressions

	(3) Share of serfs X Post-emancipation	(7.1) Share of serfs X Post-emancipation	(7.2) Share of peasants with signed buyout contracts
Dependent var:			
Model:	IV, 1st stage	IV, 1st stage	IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation	-1.24*** [0.290]	-1.27*** [0.291]	-1.32*** [0.268]
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882		0.19 [0.187]	2.76*** [0.271]
Controls as in respective column of Panel A	Yes	Yes	Yes
Observations	1,828	1,773	1,773
F, monasterial serfs instrument	18.29	19.09	24.44
F, indebtedness instrument		1.027	104.2

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861. 1861-1870 and 1871-1900 time dummies equal to 1 in corresponding years and 0 otherwise. The share of peasants with signed buyout contracts equals 0 in all provinces for the years before 1862 and then gradually reaches the share of serfs in the corresponding province. In all the non-western provinces this happened by 1882, and in western provinces there was a jump in this variable to the share of serfs in 1863. Indebtedness is the ratio of serfs in the province used as collateral in landlords' debt contracts in 1858 to the total rural population in the province.

*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A15. Robustness of the effect of the land reform to the sample restricted to the provinces where the land reform was governed by the same law, i.e., the Great Russia, New Russia and a part of Belorussia

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample:	the Great Russia, the New Russia and a part of Belorussia provinces						Full Sample	
Dependent var:	Grain productivity	Share of serfs	Share of serfs with X Post-emancipation signed buyout contracts	Grain productivity			Grain productivity	
	OLS	IV, 1 stage	IV, 1 stage	IV, 2nd stage	OLS	OLS	OLS	OLS
Share of serfs X Post-emancipation	1.26*** [0.381]			2.72*** [0.637]	1.29*** [0.386]	1.04*** [0.333]	0.90** [0.364]	1.16*** [0.340]
Share of peasants with signed buyout contracts	-0.56 [0.382]			-1.39*** [0.489]	-0.51 [0.388]	-0.38 [0.276]	-0.43 [0.260]	-0.48* [0.260]
Land cuts X Post-1863					0.00071 [0.006]	0.0016 [0.005]		
Share of serfs X Large Avreage Estate Dummy							0.16 [0.228]	
Share of pesants on quitrent X Post-emancipation								-0.78** [0.367]
Share of nationalized monasterial serfs X Post-emancipation		-0.99*** [0.319]	-1.12*** [0.323]					
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882		-0.33** [0.166]	2.15*** [0.301]					
Demeaned log distance from Moscow X Post-emancipation	-0.40 [0.535]	-1.00*** [0.108]	-0.74*** [0.116]	0.70 [0.602]	-0.67 [0.540]	-0.80* [0.449]	-0.69 [0.454]	-1.02** [0.459]
Demeaned crop suitability X Post-emancipation	0.01 [0.046]	0.03* [0.018]	0.03 [0.018]	0.01 [0.051]	-0.01 [0.047]	0.04 [0.038]	0.06 [0.040]	0.06 [0.038]
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,359	1,385	1,359	1,359	1,300	1,682	1,780	1,709
F, monasterial serfs instrument		9.579	12.13					
F, indebtedness instrument		4.014	50.89					
R-squared	0.407	0.981	0.962	0.526	0.417	0.420	0.403	0.417

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861. The share of peasants with signed buyout contracts equals 0 in all provinces for the years before 1862 and then gradually reaches the share of serfs in the corresponding province. In all the non-western provinces, this happened by 1882, and in the western provinces there was a jump in this variable to the share of serfs in 1863. Indebtedness is the ratio of serfs in the province used as collateral in landlords' debt contracts in 1858 to the total rural population in the province. Large average estate dummy equals one to provinces with an average estate of a hundred of serfs or more in 1858. Share of peasants on corvee equals to share of serfs with obligations of payments in labor in 1858.

*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A16. Robustness to deflation by rye prices using: the abolition of serfdom and industrial development

Panel A: Panel data estimation

Dependent var:	(1)	(2)	(3)	(4)
	Ln (industrial output deflated by local rye prices)			
	OLS	OLS	IV, 2nd stage	OLS
Share of serfs X	0.80**	1.14***	3.68***	1.44***
Post-emancipation	[0.320]	[0.330]	[1.368]	[0.467]
Demeaned log distance from Moscow X		0.96**	2.77**	1.07**
Post-emancipation		[0.441]	[1.112]	[0.460]
Demeaned crop suitability X		0.12*	0.13	0.13*
Post-emancipation		[0.064]	[0.077]	[0.064]
Year and province fixed effects		Yes	Yes	Yes
Region-specific trends		Yes	Yes	Yes
State and royal peasant reforms		No	No	Yes
Observations	347	347	347	347
R-squared	0.754	0.852	0.923	0.855

Panel B: First stages of the corresponding 2SLS panel regressions

	(2)
	Share of serfs X
Dependent var:	Post-emancipation
Model:	IV, 1st stage
Share of nationalized monasterial serfs X	-1.02***
Post-emancipation	[0.260]
Controls as in respective column of Panel A	Yes
Observations	347
F, excluded instrument	15.42

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.
*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1

Table A17. Robustness to using 1857 tax census data: the effect of the abolition of serfdom on grain productivity

Panel A: Panel data estimation

Dependent var:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				Grain productivity			
Model:	OLS	OLS	IV, 2nd stage	OLS		OLS	IV, 2nd stage
Share of serfs (according to 1857 tax census data) X Post-emancipation	0.90*** [0.238]	0.92*** [0.267]	1.51** [0.566]	1.19*** [0.277]		1.14*** [0.363]	3.04*** [0.746]
Share of serfs (according to 1857 tax census data) X 1861-1870					0.88*** [0.262]		
Share of serfs (according to 1857 tax census data) X 1871-1900					1.06*** [0.397]		
Share of peasants (according to 1857 tax census data) with signed buyout contracts						-0.41 [0.258]	-1.17*** [0.328]
Demeaned log distance from Moscow X Post-emancipation		-0.93** [0.377]	-0.50 [0.483]	-0.87** [0.374]	-0.92** [0.376]	-0.64 [0.431]	0.71 [0.537]
Demeaned crop suitability X Post-emancipation		0.09** [0.042]	0.09* [0.043]	0.09** [0.039]	0.09** [0.042]	0.09** [0.041]	0.09* [0.047]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes	Yes
Share of state peasants (according to 1857 tax census data) X Post-1866	No	No	No	Yes	No	No	No
Share of royal peasants (according to 1857 tax census data) X Post-1859	No	No	No	Yes	No	No	No
Observations	1,758	1,758	1,758	1,758	1,758	1,715	1.715
R-squared	0.372	0.411	0.545	0.413	0.411	0.410	0.548

Panel B: First stages of the corresponding 2SLS panel regressions

Dependent var:	(3)		(7.1)	(7.2)
	Share of serfs X Post-emancipation		Share of serfs X Post-emancipation	Share of peasants with signed buyout
Model:	IV, 1st stage		IV, 1st stage	IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation	-1.03*** [0.266]		-1.07*** [0.272]	-1.16*** [0.249]
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882			0.08 [0.166]	2.59*** [0.241]
Controls as in respective column of Panel A	Yes		Yes	Yes
Observations	1,758		1,715	1,715
F, monasterial serfs instrument	15.11		15.37	21.77
F, indebtedness instrument	0.221		0.221	115.7

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861. 1861-1870 and 1871-1900 time dummies equal to 1 in corresponding years and 0 otherwise. The share of peasants with signed buyout contracts equals 0 in all provinces for the years before 1862 and then gradually reaches the share of serfs in the corresponding province. In all the non-western provinces this happened by 1882, and in western provinces there was a jump in this variable to the share of serfs in 1863. Indebtedness is the ratio of serfs in the province used as collateral in landlords' debt contracts in 1858 to the total rural population in the province.
*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A18. Robustness to using 1857 tax census data: the mechanisms behind the effects of the land reform and the emancipation

Dependent var:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Grain productivity		Share of winter crops seeded at t-1 in total winter and summer crops seeded at [t-1;t] production cycle				
	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Share of serfs (according to 1857 tax census data) X Post-emancipation	0.92** [0.356]	1.92*** [0.446]	-0.11*** [0.029]	-0.04*** [0.016]	-0.10*** [0.029]	-0.03 [0.022]	-0.13*** [0.033]
Share of peasants (according to 1857 tax census data) with signed buyout contracts	0.18 [0.302]	-0.51** [0.258]					
Share of peasants (according to 1857 tax census data) with signed buyout contract X repartition commune dummy	-0.77** [0.360]						
Share of serfs (according to 1857 tax census data) X Post-emancipation X Implicit contracts		-1.71*** [0.573]					
Demeaned temperature (t-1)			0.004 [0.003]		0.003 [0.003]		0.004 [0.003]
Share of serfs (according to 1857 tax census data) X Post-emancipation X Demeaned temperature (t-1)			0.01** [0.004]		0.01* [0.004]		0.01*** [0.005]
Share of serfs (according to 1857 tax census data) X Post-emancipation X Demeaned rye-to-wheat world price ratio (t-1)				-0.42*** [0.097]	-0.37*** [0.100]		
Share of serfs (according to 1857 tax census data) X Post-emancipation X Demeaned rye-to-oat local price ratio (t-1)						-0.10** [0.043]	-0.11*** [0.042]
Share of serfs (according to 1857 tax census data) X Demeaned rye-to-oat local price ratio (t-1)						0.02 [0.046]	0.03 [0.043]
Demeaned rye-to-oat local price ratio (t-1)						0.02 [0.019]	0.01 [0.017]
Demeaned log distance from Moscow X Post-emancipation	-0.96** [0.458]	-0.80* [0.435]	-0.03 [0.020]	0.02 [0.017]	-0.02 [0.020]	0.02 [0.020]	-0.04* [0.022]
Demeaned crop suitability X Post-emancipation	0.07* [0.040]	0.06* [0.036]	0.002 [0.002]	0.0004 [0.002]	0.001 [0.002]	0.001 [0.003]	0.003 [0.002]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,715	1,644	761	765	761	729	721
R-squared	0.411	0.428	0.833	0.832	0.839	0.825	0.835

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.

*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A19. Robustness to using 1857 tax census data: the effect of the abolition of serfdom on industrial output

Panel A: Panel data estimation

Dependent var:	(1)	(2)	(3)	(4)
		Ln (industrial output)		
	OLS	OLS	IV, 2nd stage	OLS
Share of serfs (according to 1857 tax census data) X Post-emancipation	0.54 [0.344]	0.60 [0.461]	3.11* [1.552]	1.19* [0.710]
Demeaned log distance from Moscow X Post-emancipation		0.32 [0.465]	2.11* [1.224]	0.41 [0.468]
Demeaned crop suitability X Post-emancipation		0.12* [0.066]	0.15** [0.073]	0.14** [0.065]
Year and province fixed effects	Yes	Yes	Yes	Yes
Region-specific trends	No	Yes	Yes	Yes
Share of state peasants (according to 1857 tax census data) X Post-1866	No	No	No	Yes
Share of royal peasants (according to 1857 tax census data) X Post-1859	No	No	No	Yes
Observations	340	340	340	340
R-squared	0.797	0.884	0.931	0.886

Panel B: First stage of the corresponding 2SLS panel regression

	(3)
Dependent var:	Share of serfs X Post-emancipation
Model:	IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation	-0.84*** [0.234]
Controls as in respective column of Panel A	Yes
Observations	340
F, monasterial serfs instrument	12.81

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.
 *** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1

Table A20. Robustness to using 1857 tax census data: the effect of the abolition of serfdom on draftees' height

Panel A: Panel data estimation

	(1)	(2)	(3)
Dependent var:	Draftees' height (cohorts 1853-1866)		
Data set:	Province-level data		
Model:	OLS	OLS	IV, 2nd stage
Share of serfs (according to 1857 tax census data) X	0.67***	0.96***	0.99**
Post-emancipation cohorts	[0.159]	[0.139]	[0.388]
Demeaned log distance from Moscow X		0.76***	0.78***
Post-emancipation		[0.193]	[0.296]
Demeaned crop suitability X		0.17***	0.17***
Post-emancipation		[0.024]	[0.023]
Birth cohort and province fixed effects	Yes	Yes	Yes
Province-specific trends	No	No	No
Observations	570	570	570
R-squared	0.104	0.222	0.858

Panel B: First stage of the corresponding 2SLS panel regression

	(3)
Dependent var:	Share of serfs X Post-
Model:	IV, 1st stage
Share of nationalized monasterial serfs X	-1.07***
Post-emancipation cohorts	[0.283]
Controls as in respective column of Panel A	Yes
Observations	570
F, excluded instrument	14.22

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.
*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A21. The effect of the abolition of serfdom on grain productivity in the subsample with data from governor reports only

Panel A: Panel data estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent var:				Grain productivity			
Sample:			Data on grain productivity from governor reports only				
Model:	OLS	OLS	IV, 2nd stage	OLS		OLS	IV, 2nd stage
Share of serfs X Post-emancipation	1.08*** [0.167]	0.70*** [0.246]	1.90*** [0.504]	0.90*** [0.259]		0.55 [0.350]	2.74*** [0.639]
Share of serfs X 1861-1870					0.67*** [0.247]		
Share of serfs X 1871-1900					0.87** [0.332]		
Share of peasants with signed buyout contracts						0.14 [0.248]	-0.82* [0.442]
Demeaned log distance from Moscow X Post-emancipation		-0.58* [0.334]	0.25 [0.382]	-0.55* [0.329]	-0.58* [0.336]	-0.75* [0.410]	0.76 [0.503]
Demeaned crop suitability X Post-emancipation		0.02 [0.036]	0.02 [0.046]	0.02 [0.035]	0.02 [0.037]	0.01 [0.037]	0.01 [0.054]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes	Yes
Share of state peasants X Post-1866	No	No	No	Yes	No	No	No
Share of royal peasants X Post-1859	No	No	No	Yes	No	No	No
Observations	1,010	1,010	1,010	1,010	1,010	955	955
R-squared	0.238	0.289	0.500	0.293	0.289	0.300	0.515

Panel B: First stage of the corresponding 2SLS panel regression

	(3)	(7.1)	(7.2)
Dependent var:	Share of serfs X Post-emancipation	Share of serfs X Post-emancipation	Share of peasants with signed buyout contracts
Model:	IV, 1st stage	IV, 1st stage	IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation	-1.45*** [0.318]	-1.45*** [0.332]	-1.38*** [0.293]
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882		0.05 [0.188]	2.37*** [0.318]
Controls as in respective column of Panel A	Yes	Yes	Yes
Observations	1,010	955	955
F, monasterial serfs instrument	20.88	19.09	22.12
F, indebtedness instrument		0.0689	55.16

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861. 1861-1870 and 1871-1900 time dummies equal to 1 in corresponding years and 0 otherwise. The share of peasants with signed buyout contracts equals 0 in all provinces for the years before 1862 and then gradually reaches the share of serfs in the corresponding province. In all the non-western provinces this happened by 1882, and in western provinces there was a jump in this variable to the share of serfs in 1863. Indebtedness is the ratio of serfs in the province used as collateral in landlords' debt contracts in 1858 to the total rural population in the province.

*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A22. The effect of the abolition of serfdom on grain productivity in the sample including the Baltic provinces

Dependent var:	(1)	(2)	(3)	(4)
		Grain productivity		
	OLS	OLS	OLS	OLS
Share of serfs X Post-emancipation	0.85*** [0.242]	1.01*** [0.258]		
Share of non-Baltic serfs X Post-1861			0.79*** [0.248]	1.02*** [0.254]
Share of Baltic serfs X Post 1820			1.11 [0.736]	0.99 [0.759]
Demeaned log distance from Moscow in non-Baltic provinces X Post-1861	-0.89** [0.353]	-0.88** [0.355]	-0.94** [0.361]	-0.88** [0.361]
Demeaned log distance from Moscow in Baltic provinces X Post-1861	3.42 [2.438]	2.63 [2.458]	3.24 [2.505]	2.64 [2.544]
Demeaned crop suitability in non-Baltic provinces X Post-1861	0.06 [0.041]	0.06 [0.039]	0.07 [0.041]	0.06 [0.039]
Demeaned crop suitability in Baltic provinces X Post-1861	0.22 [0.135]	0.30** [0.142]	0.22* [0.133]	0.30** [0.140]
Share of state peasants X Post-1866	No	Yes	No	Yes
Share of royal peasants X Post-1859	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes
Observations	1,944	1,944	1,944	1,944
R-squared	0.395	0.397	0.395	0.397

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.
 *** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1

Table A23. Robustness to using WLS with weights by log provincial population: the effects of the abolition of serfdom on productivity in agriculture

Panel A: Panel data estimation

Dependent var:	(1)	(2)	(3)	(4)	(5) Grain productivity	(6)	(7)
Model:	WLS	WLS	weighted IV, 2nd stage	WLS		WLS	weighted IV, 2nd stage
Share of serfs X Post-emancipation	0.81*** [0.231]	0.80*** [0.256]	1.34*** [0.461]	1.03*** [0.263]		1.04*** [0.350]	2.79*** [0.614]
Share of serfs X 1861-1870					0.75*** [0.243]		
Share of serfs X 1871-1900					0.98** [0.375]		
Share of peasants with signed buyout contracts						-0.41 [0.252]	-1.20*** [0.320]
Demeaned log distance from Moscow X Post-emancipation		-0.95** [0.369]	-0.57 [0.421]	-0.88** [0.369]	-0.95** [0.362]	-0.64 [0.427]	0.60 [0.467]
Demeaned crop suitability X Post-emancipation		0.06 [0.041]	0.06 [0.044]	0.06 [0.039]	0.06 [0.041]	0.06 [0.040]	0.05 [0.048]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes	Yes
State and royal peasant reforms	No	No	No	Yes	No	No	No
Observations	1,835	1,835	1,835	1,835	1,835	1,780	1,780
R-squared	0.509	0.536	0.536	0.537	0.406	0.545	0.541

Panel B: First stages of the corresponding 2SLS panel regressions

Dependent var:	(3) Share of serfs X Post-emancipation	(7.1) Share of serfs X Post-emancipation	(7.2) Share of peasants with signed buyout contracts
Model:	weighted IV, 1st stage	weighted IV, 1st stage	weighted IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation	-1.24*** [0.290]	-1.28*** [0.293]	-1.33*** [0.272]
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882		0.12 [0.174]	2.70*** [0.257]
Controls as in respective column of Panel A	Yes	Yes	Yes
Observations	1,835	1,780	1,780
F, monasterial serfs instrument	18.29	19	24.02
F, indebtedness instrument		0.464	110.4

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861. The share of peasants with signed buyout contracts equals 0 in all provinces for the years before 1862 and then gradually reaches the share of serfs in the corresponding province. In all the non-western provinces this happened by 1882, and in western provinces there was a jump in this variable to the share of serfs in 1863. Indebtedness is the ratio of serfs in the province used as collateral in landlords' debt contracts in 1858 to the total rural population in the province.

*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A24. Robustness to using WLS with weights by log provincial population: the mechanisms behind the effects of the land reform and the emancipation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent var:	Grain productivity		Share of winter crops seeded at t-1 in total winter and summer crops seeded at [t-1;t] production cycle				
	WLS	WLS	WLS	WLS	WLS	WLS	WLS
Share of serfs X Post-emancipation	0.84** [0.339]	1.75*** [0.437]	-0.07*** [0.017]	-0.05*** [0.017]	-0.07*** [0.018]	-0.04* [0.022]	-0.08*** [0.020]
Share of peasants with signed buyout contract	0.11 [0.271]	-0.51** [0.255]					
Share of peasants with signed buyout contract X repartition commune	-0.71** [0.341]						
Share of serfs X Post-emancipation X Implicit contracts		-1.58*** [0.537]					
Demeaned temperature (t-1)			0.01* [0.003]		0.003 [0.003]		0.01* [0.003]
Share of serfs X Post-emancipation X Demeaned temperature (t-1)			0.01** [0.004]		0.01** [0.004]		0.01*** [0.005]
Share of serfs X Post-emancipation X Demeaned rye-to-wheat world price ratio (t-1)				-0.50*** [0.124]	-0.45*** [0.123]		
Share of serfs X Post-emancipation X Demeaned rye-to-oat local price ratio (t-1)						-0.10** [0.044]	-0.11*** [0.043]
Share of serfs X Demeaned rye-to-oat local price ratio (t-1)						-0.01 [0.049]	0.01 [0.045]
Demeaned rye-to-oat local price ratio (t-1)						0.03 [0.023]	0.02 [0.020]
Demeaned log distance from Moscow X Post-emancipation	-0.93** [0.446]	-0.79* [0.428]	-0.03 [0.020]	0.02 [0.018]	-0.02 [0.020]	0.02 [0.021]	-0.04* [0.023]
Demeaned crop suitability X Post-emancipation	0.04 [0.040]	0.04 [0.036]	0.001 [0.002]	-0.001 [0.002]	0.0004 [0.002]	-0.001 [0.002]	0.002 [0.002]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,780	1,726	792	796	792	755	751
R-squared	0.545	0.554	0.931	0.931	0.934	0.928	0.933

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861. The share of peasants with signed buyout contracts equals 0 in all provinces for the years before 1862 and then gradually reaches the share of serfs in the corresponding province. In all the non-western provinces this happened by 1882, and in western provinces there was a jump in this variable to the share of serfs in 1863.

*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1.

Table A25. Robustness to using WLS with weights by log provincial population: the effects of the abolition of serfdom on industrial output

Panel A: Panel data estimation

Dependent var:	(1)	(2)	(3)	(4)
		Ln (industrial output)		
	WLS	WLS	eighted IV, 2nd sta	WLS
Share of serfs X Post-emancipation	0.78** [0.335]	0.71* [0.424]	2.60* [1.225]	1.38** [0.621]
Demeaned log distance from Moscow X Post-emancipation		0.33 [0.474]	1.67* [1.002]	0.49 [0.479]
Demeaned crop suitability X Post-emancipation		0.12* [0.070]	0.12* [0.070]	0.12* [0.070]
Year and province fixed effects	Yes	Yes	Yes	Yes
Region-specific trends	No	Yes	Yes	Yes
State and royal peasant reforms	No	No	No	Yes
Observations	347	347	347	347
R-squared	0.897	0.941	0.935	0.942

Panel B: First stages of the corresponding 2SLS panel regressions

Dependent var:	(2) Share of serfs X Post- emancipation
Model:	weighted IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation	-1.02*** [0.261]
Controls as in respective column of Panel A	Yes
Observations	347
F, excluded instrument	15.41

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.
 *** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1

Table A26. Robustness to using WLS with weights by log provincial population: the effects of the abolition of serfdom on height

Panel A: Panel data estimation

	(1)	(2)	(3)
Dependent var:		Draftees' height (cohorts 1853-1866)	
Data set:		Province-level data	
Model:	WLS	WLS	weighted IV, 2nd stage
Share of serfs X Post-emancipation cohorts	0.76*** [0.163]	0.91*** [0.134]	0.77** [0.316]
Demeaned log distance from Moscow X Post-emancipation		0.72*** [0.182]	0.64*** [0.235]
Demeaned crop suitability X Post-emancipation		0.16*** [0.023]	0.16*** [0.023]
rth cohort and province or district fixed effects	Yes	Yes	Yes
Province-specific trends	No	No	No
Observations	584	584	584
R-squared	0.834	0.854	0.853

Panel B: First stages of the corresponding 2SLS panel regressions

	(2)
Dependent var:	Share of serfs X Post-emancipation cohorts
Model:	weighted IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation cohorts	-1.28*** [0.305]
Controls as in respective column of Panel A	Yes
Observations	584
F, excluded instrument	17.56

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.
*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1

Appendix Sections

A. <u>Historical background</u>

A1. Contemporaries on the economic consequences of the abolition of serfdom

The abolition of serfdom gave rise to a debate among contemporaries about the impact of the reform on the growth of Russian agriculture and on the living standards of former serfs.

On the one hand, halfway through the implementation of the land reform, the government formed the special commission to evaluate the development of Russian agriculture and agricultural productivity after the abolition of serfdom, the so-called Valuev commission, named after its chair, the minister of internal affaires, Pyotr Valuev. In 1872 the commission conducted a detailed survey of about one thousand experts in forty-one European provinces of the empire and published the survey responses (see Commission on development of agriculture and agricultural productivity in Russia, 1873a,b). Survey participants were drawn from different social strata and occupations: landowners, local officials, peasants, agricultural specialists, and priests. The survey sample was not random, but the experts were chosen to cover as many regions as possible (Mironov 2010). Questions covered respondents' assessment of the effect of the abolition of serfdom on the productivity and efficiency of agricultural farms and on peasants' living standards during the 1860s and the first two years of 1870s. Respondents gave answers to a set of questions in a free form and could choose which questions of answer. Mironov (2010) classified the answers into three groups: positive, negative and neutral effect of the abolition of serfdom on several outcomes related to the economic performance of peasants' and gentry's farms as well as peasants' living standards. Figure A1 in this online appendix reports Mironov's classification of the answers. For each outcome under consideration, the positive evaluation of the impact of the abolition of serfdom was given by the largest group of respondents. For example, 55% of respondents positively evaluated the impact of the abolition of serfdom on the economic performance of peasants' farms and 63% on peasants' living standards. Less than a third of respondents evaluated the effects of the abolition of serfdom as negative irrespective of the outcome. The 1872 commission concluded, "*positive consequences of the reform are more or less clear ... Living standards of the rural population substantially increased; rural citizens became owners of their labor and could chose how to use it*" (Commission on development of agriculture and agricultural productivity in Russia, 1873a p. 40).

Those survey respondents who noticed improvements in Russian agriculture, directly linked them to the abolition of serfdom, arguing that former serfs became more productive workers because of better incentives after the emancipation. Peasants *"got a feeling that they are independent producers"*; they "*became full owners of their time*" and "*could decide how to allocate it*" (Commission on development of agriculture and agricultural productivity in Russia, 1873b, vol. 6 part 1, p.95 and vol. 6, part 2, p.16). Survey respondents stressed better incentives for peasants to exert effort, invest in land, and use new, more productive crops, for example: *"The situation of peasants recently has improved considerably because, having received their plots, peasants try to improve the land as much as possible, fertilize it and take care of it, so the land produces more than ever before,"* (Commission on development of agriculture and agricultural productivity in Russia, 1873b, vol. 6 part 1. p. 28*)*.

However, many contemporaries and historians have argued that the government commission may have had incentives to misrepresent the real outcomes of the reform and that former serfs did not gain much from the emancipation (e.g., Kornilov 1905, Lyashchenko 1913, Titov 1907, Yanson 1877). For example, Pyotr Struve, argued that the way in which the emancipation and the subsequent land reform were conducted, caused an "agrarian crisis" in rural areas that had long-lasting negative implications. Struve (1913) did acknowledge the apparent growth in the second half of the 19th century but argued that the only reason why there was no substantial decrease in output following the abolition of serfdom was the railway construction (p. 110). However, he also acknowledged the relatively low productivity of serf labor as compared to free labor (p. 91). In contrast, the critics of 'agrarian crises' hypothesis argued that Valuev's commission collected reasonable evidence, which portrayed the improvement of peasants' well-being (Bogushevich 1881).

A2. Legal status of Russian peasants, whom we characterize as (relatively) free population

__State peasants:__ Formerly, state peasants (40.4% of the rural population in 1858) were free individuals living and working on land belonging to the state. By law, they had personal and property rights and could change their occupation and place of living (Svod … 1857, vol. 9). The required administrative procedure for moving was so complicated, however, that few actually did this.[1] State peasants had to pay a lease payment (in the form of a quitrent) to the state in an amount fixed by the law in return for the ability to cultivate the land. A special ministry regulated the magnitude of the quitrent as well as the types of actual agricultural production. The ministry changed the quitrent only rarely (three times in the 18th and four times in the 19th century). Historians agree that the living standards of state peasants were higher, individual land plots were larger, and the system of quitrent was more transparent than that of serfs (Druzhinin 1958). In the late 1830s - 1840s the government conducted the so-called Kiselev reforms, which guaranteed a minimum amount of land to each state-peasant household and improved the administration of the state-peasant villages. If the population in these villages grew above the minimum required land-household ratio, the state initiated migration programs to virgin lands south and east of the empire (Druzhinin 1958; Crisp 1976).

We count former military dwellers, i.e., soldiers in special regiments who were supposed to participate in agriculture along with their military service, as state peasants. The state established the group of military dwellers in 1810 to economize on military expenditures. For that purpose, the government selected several regular regiments and settled them down on state lands in military settlements. Military settlements were abandoned in 1857, and former military dwellers legally became state peasants (Kandaurova 1990).

__Free agricultural laborers:__ Free peasants with or without land titles constituted 12.6% of the rural population in 1858. The free peasant population was present in all provinces in small numbers and consisted of former retired soldiers (including soldiers in reserve and soldiers' children, so called cantonists) and colonists invited by the government during the 18th century

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[1] Note that state peasants were free only relative to serfs. In the 18th century, the tsars often granted state lands with state peasants on these lands to nobility as private estates; in that case, state peasants acquired the status of serfs. State peasants described themselves in the following way in the 18th century: "*we are not free, we belong to the state*" (Crisp 1976 p. 76).

and the first half of the 19th century under special arrangements.[2] There were three provinces on the outskirts of the empire where the free peasant population constituted the majority of the population. Cossacks in the Don region were free because, in the 17th century, the government needed them to protect the country against nomadic invaders from the south. The state also granted free status to local non-Russians in the Volga region after the conquest of this region in order to avoid rebellion by the new imperial subjects. Similarly, the peasants of Bessarabia (*tsaryane*) were granted a special status as a (relatively) free rural population after the conquest of this province in 1811. "*Tsaryane*" were free because they could move between landlords' estates; where they cultivated land in return for an obligation to the landlord (Antsupov 1978). In addition, after the 1819 reform, the largely landless peasants in the three Baltic provinces became free laborers.

Royal peasants: Royal ("appanage," *udel'nye*) peasants constituted another, much less numerous, group of the (relatively free) peasantry. Formally, they were serfs on quitrent who belonged to the royal family. However, they were managed by a special ministry (Ministry of Appanages), which made them *de facto* very similar to state peasants under fixed land lease. They were formally emancipated in 1858-1859 and got land reform in 1863 (Istoriya … 1901).

A3. The reasons geographical concentration of serfdom in the center of the empire

In the 16th and 17th centuries, being short of cash, the government gave out state lands with peasants to the gentry in return for their military service. The government transferred lands to the gentry more often in regions closer to Moscow for two reasons: 1) the gentry had to be mobilized to the capital quickly in case of war; and 2) the government had more power nearby the capital to enforce serfdom (Semevskij 1881, pp. 29-30). Over time, due to a short supply of remaining state lands in the old regions and the colonization of new territories, the state transferred more distant lands with peasants to the gentry as well. The government continued this practice of transfers throughout the 18th century (even after instituting the regular army in 1704). In particular, Catherine II (1762-1796) transferred 800,000 state peasants to private owners; Pavel I (1796-1801) transferred another 400,000 (Semevskij 1881, 1901, 1906). Only Alexander I, who assumed the throne in 1801, ordered a stop of the practice of transfers of state lands. Alexander I and his successor, Nicolas I, however, exchanged state peasants in some provinces for a similar number of royal peasants in other provinces in order to have a more compact spatial distribution of royal peasants (Nifontov 1974 P. 100; Crisp 1976).

In addition, gentry often illegally captured state lands with state peasants on them, eventually legalizing their titles. Using the 1684-1686 household tax census data, Vodarskij (1988) estimates that 36 percent of all privately owned estates were on captured lands. This share was higher in the "black earth" region where soil was most fertile; the state was too weak to enforce state ownership of these lands. Tsars only managed to keep the very best lands in their own personal ownership as royal estates (Indova 1964).

A4. The nationalization of monasterial lands

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[2] The bulk of immigration of colonists took place under the rule of Elizabeth the First (1741-1761) and Catherine the Second (1762-1796), i.e., before the period of our study. There are no data on the colonization after 1800, however, it is known that the number of immigrants was low. Between 1804 and 1819, the law allowed accepting no more than 200 migrant families per year in the empire; after 1819, every case of immigration was regulated by a special decree signed by the emperor. This happened very rarely. The 1851 decree allowed a hundred of German families to move into Samara province; the 1860 decree allowed Slaves from Turkey to move into Russia (Colonists in Entciklopedicheskii … 1890—1907, vol. XXIVa, 1898).

The royal family and individual landowners had granted lands to the Orthodox Church since the Christianization of Russia in the 10th century. The bulk of church lands belonged to monasteries, which accumulated most of their property in the 15th and 16th centuries (Vodarskii 1988), i.e., before the start of serfdom in Russia. With the establishment of serfdom in the late 16th – mid-17th century, peasants who lived on church lands became serfs belonging to the Russian Orthodox Church. The church owned about 2 million serfs or about 14.1% of the population of the empire at the moment of the nationalization of church property in the second half of the 18th century. About one half of all monasteries had serfs (Zakharova 1982). In addition, in provinces of the Russian empire that were added as a result of the partitions of Polish-Lithuanian Commonwealth at the end of the 18th century there were serfs that belonged to the Roman and Eastern Catholic churches (Zinchenko 1985).

Church serfs faced the same constraints as other privately owned serfs and used similar agricultural technologies and practices (Gorskaya 1977; Zakharova 1982). Historians do not find any evidence of any systematic difference in the quality of land between monasteries and private estates, in the literacy rates between monasterial and other private serfs, or in the level of religiosity between monasterial serfs and other Russian peasants (Buligin 1977, Gorskaya 1977).[3]

The rise of the modern state in Russia in the 18th century was associated with the accumulation of absolutist political power in the hands of the monarchs, which allowed them to progressively confiscate Church property. First, Peter the Great took all Orthodox Church property under state control in 1701. The government created a special department that managed church estates and collected all revenues from them, transferring a part of the revenues to church institutions to finance their activities. In 1744, however, the Church managed to regain control over the revenue from its property. Second, Catherine the Great nationalized Church property (Shchapov 1989). This nationalization took place in 1764 in the core part of the Russian Empire and between 1786 and 1788 in the Ukrainian provinces and Southern Russian provinces (Kursk and Voronezh). The nationalization of the property of the Roman and Eastern Catholic churches in provinces integrated into the empire as a result of the partitions of Poland took longer. The first wave of nationalizations of such estates took place immediately after the second and the third partitions of the Polish-Lithuanian Commonwealth in 1793-1795 and affected the monasteries and bishops who took an active anti-Russian position. Similarly, the 1830 Polish rebellion led to the closing of 191 catholic monasteries (out of 304) and the confiscation of their 204 estates (Zinchenko 1985). In 1822, the Russian government abolished the order of Jesuits and confiscated its property (Zinchenko 1983). Between 1828 and 1839, all monasteries of the Eastern Catholic churches, which owned 23,000 serfs, were closed. The nationalization of Catholic Church property was completed by the government in 1841-1842, when it nationalized the last five hundred church estates with about 100,000 serfs on them (Zinchenko 1985). Former monasterial serfs got the legal status of state peasants as a result of these reforms (Shchapov 1989). The vast majority of the former monasterial serfs retained the status of state peasants until the emancipation reform. The government avoided granting former monasterial estates to gentry in order not to provoke additional conflict with the church (Zakharova 1982).

A5. The timing of the abolition of serfdom

The Russian government started to discuss the emancipation reform long before the abolition of serfdom actually happened in 1861, in the late 18th – early 19th centuries (Dolgikh 2006). Alexander I (1801-1825) considered the introduction of various restrictions of landlords'

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[3] It is the religiosity of landowners (rather than peasants living on these lands) was the overriding motive behind the flow of testaments and private donations of land to the Church.

authority over serfs, including the abolition of serfdom altogether. He was influenced by the spread of the ideas of the Enlightenment and the emancipation reforms in the Habsburg and Prussian empires (in 1781 and 1809, respectively). However, the vast majority of the considered measures were not adopted. Alexander I ventured to liberate serfs only in the outskirts of the empire, in particular, in the three Baltic provinces (1816-1819), and to implement reforms that only marginally affected serfdom, such as the 1801 and 1803 decrees allowing landlords to liberate peasants at their private will, or the 1809 prohibition on landlords penalizing serfs by sending them to penal works in Siberia. Alexander's successor, Nicolas I (1825-1855) also considered an emancipation reform. During his reign he organized a number of secret committees to discuss it, none of which resulted in a political action (Mironenko 1990; Zajonckovskij 1968).

The gentry's opposition to emancipation was the main political obstacle forcing the government to postpone the reform. Serfdom remained profitable for the gentry until its very end. Dormar and Machina (1984) disentangled prices on serfs and land from the historically known prices of estates (the law prohibited selling serfs without land in the first half of the 19th century) and showed that serfs had positive value. In the 1840s and 1850s, the prices of licenses that allowed the serfs to avoid the draft into the army were high: 485 silver rubles or about ten times the annual GDP per capita (Obruchev 1871). Historical literature views these licenses as a proxy for the price of serfs (Dormar and Machina 1984).

The defeat in the Crimean War (1853-1856) demonstrated that Russia lagged behind the most developed countries in terms of economic and technological development. This convinced the skeptics of the necessity of structural reforms, including the abolition of serfdom. While the new government of Alexander II (1855-1881) used the defeat as a motivating factor to overcome the gentry's opposition to the liberation of serfs, it took the government more than five years to enact the reform (Zakharova 1984).

A6. Details of the land reform

The government defined the rules of the future land reform in 1861 in a series of decrees issued together with the emancipation manifesto of February 1861 (Polnoe … 1863, vol. 36, part 1). The law obliged emancipated serfs to buy out the land from the landlord but the timing and the precise conditions of the land reform (the land plots and the price) in each particular estate were a subject of negotiations between the landlord and his former serfs.[4] If an agreement was not reached, the law prescribed the terms of the fallback deal. Four emancipation statutes governed local parameters of the bargaining menus in different parts of the empire. The main statute regulated the abolition of serfdom in the core provinces of the empire, i.e., the Great Russia, New Russia and the Eastern part of Belorussia, i.e., the thirty-five out of forty-six provinces. In the western provinces (for instance, the right-bank Ukraine, Byelorussia and Lithonia), the menus were less favorable for gentry, and the parties were given less time to implement the land reform.[5] The land reform took place between 1862 and 1882 with varying speed in different provinces. In western provinces, where land reform was the fastest, the legislation mandated that peasants and landlords sign the buyout contract in 1863, following the Polish rebellion. The land reform transferred property titles on peasant

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[4] The law explicitly prohibited peasants from quitting the countryside without buying out the land before 1870 (Polnoe … 1863, vol. 36, part 1). After 1870, in order to quit their villages without buying the land, peasants had to satisfy a number of restrictive conditions. In practice, less than one percent of peasants chose quitting without exercising the buyout of land (Litvak 1972).

[5] Initially, the rules were similar throughout the empire. The change in the rules was caused by the 1863 Polish rebellion. The government introduced pro-peasant changes for political reasons. The vast majority of former serfs were Ukrainians or Byelorussians in these regions, whereas the landlords were Polish. The new legislation for the western provinces required no land cuts and reduced redemption payments for peasants.

land to the commune rather than to individual households, which empowered the commune making it the most important institution in the Russian village after the abolition of serfdom.[6] Major decisions were made through direct democracy at the general commune assembly (*schod*), where each peasant household had one vote. The assembly also elected a local village executive, who made day-to-day minor decisions (Bartlett 1990).

The first stage of the land reform. The negotiations between the peasants and the landlord proceeded in two stages. During the first two years after the emancipation (until 1863), the landlord and the peasants had to agree on the terms of the regulatory charter (*ustavnaya gramota*) that fixed the land plots in peasants' use, and the lease they had to pay in exchange for the use of the land during the transition period, before the signature of the buyout contract.[7] The landlord was supposed to produce a draft of the charter, which the peasants could accept or reject. The charter had to be authorized by a local official, called a "peace arbitrator" (*mirovoj posrednik*), and if there was no agreement, the local official had to produce the fallback document on his own, following the law (Easley 2008). It was easier to reach an agreement if landlords did not revise peasants' obligations under serfdom, in such cases, regulatory charters often closely followed the terms of the previously existing implicit contract between the landlord and the peasants. Litvak (1972) argued that that the changes in land use (either in terms of the amount of land or the amount of payments for the land use) were the most often the reason why peasants in the Black Earth region turned down regulatory charters. Rozov (1998) made similar conclusions on studying the elaboration of regulatory charters in Novgorod province. This is why we use the share of serfs who singed regulatory charters as a proxy for implicit long-term contracts under serfdom.

Other factors, like the attitude and the skills of the local peace arbitrators as well as local conditions, could affect peasants' decision to sign or reject suggested drafts of the charters. However, a systematic bias in our measure of the implicit contracts under serfdom is unlikely. The central government deliberately set up an institution of peace arbitrators as an independent institution from both the local gentry and the local bureaucracy. Only nobles with a certain level of wealth could be appointed as peace arbitrators. Nonetheless, the number of volunteers, who applied for this job, exceeded the number of open positions. The gentry tried to lobby for the right of local landlords to appoint peace arbitrators, but these attempts failed. Formally, the governors appointed peace arbitrators. However, the central authorities selected the candidates. The central government's aim was to select people with pro-emancipation views. Historians, who studied peace arbitrators (Easley 2008, Ustyantzeva 1992) claim that this aim was accomplished, at least in the case of the peace arbitrators appointed in 1861, i.e., those who actually arbitrated the signing of the regulatory charters. Peace arbitrators were appointed for three years and could not be fired, which made them immune to local pressures. They were directly subordinated to the Senate in Saint Petersburg rather than to local governors (Easley 2008, Ustyantzeva 1992).

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[6] The landlords constrained the power of the commune before the emancipation (Semevskii 1903). They continued to counterbalance the power of the commune during the transition period. In particular, during the first eight years post-emancipation the landlord had a legal right to reallocate communal and landlord plots within the estate without peasants' consent. The landlord kept some administrative power over former serfs until 1870. It was only the signature of the buyout contract that made the commune a full owner of the peasant land completely removing the landlord from bargaining process. Importantly, The abolition of serfdom did not affect the types of the communes. Whether the communes were re-partition or hereditary was determined by the tradition formed long before the abolition of serfdom (Zajonckovskij 1968).

[7] Before the regulatory charter was produced, peasants had to continue to carry out their obligations as they existed before the emancipation, but the law limited their amount. The law required monetary quitrent to be paid in the same amount as before the emancipation, abolished some types of in-kind payments and reduced payments in labor (Polnoe … 1863, vol. 36 part 1).

About one-half of all former serfs signed the regulatory charters following an agreement with the landlord (Zajonckovskij 1968). The law defined the maximum and the minimum amount of land that peasants could get as a result of the land reform and outlined the peasants' obligations per unit of land (Polnoe … 1863, vol. 36, part 1).[8] After the emancipation, the land became the main asset of the landlords, and they tried to keep as much land in their possession as possible. On average, peasants got less land as a result of the reform than they cultivated before the reform (while in some provinces they got more).[9] According to calculations by Soviet historians, land-cuts were up to one-third of all peasant pre-reform land as a result of the first stage of the land reform. The size of such land cuts was the largest in the Great Russian provinces (Litvak 1972; Zajonckovskij 1968).

Formally the level of temporary obligations of the emancipated serfs to their landlords, which was fixed by the reform, could not exceed the pre-emancipation level (Polnoe … 1863, vol. 36 part 1). Historians, however, argue that these legal restrictions were not always implemented in practice. For example, a leading Soviet historian of serfdom, Zajonckovskij (1968, p. 244), argued that the abolition of serfdom led to a decrease in labor payments (corvee) of former serfs, whereas the in-kind and monetary payments per unit of land (quitrent) could go both up and down depending on the land redistribution between the landlords and peasants as a result of the reform. Gerschenkron believed that "*it is unlikely that the aggregate annual burden was higher than the previous quitrent*" (Gerschenkron 1965 p. 741). He, however, did not say anything about the changes in labor obligations.

The second stage of the land reform. Once the charter was produced, the buyout contract could be signed by mutual agreement between the landlord and the peasants. The signature of the buyout contract marked the second (and final) stage of the land reform, i.e., the transfer of land ownership to the peasant commune in exchange for the obligatory redemption of the value of the land and the cessation of any temporary obligations of the peasants to the landlord. The buyout contract determined the amount that peasants needed to pay to buy out the land into the communal ownership.[10] The charter's terms were used as a focal point for determining the value and the exact plots of the land for the buyout contract, such that the land price was determined as a capitalized quitrent (or corvee equivalent) fixed in the charter. Peasants paid up to twenty percent of the land price (either momentarily or as an "additional series of payments" that were stretched over a longer period), and the state provided a loan for the other eighty percent of the value of the land. Peasants had to repay this loan to the state in annual installments during the next 49 years (Polnoe … 1863, vol. 36, part 1).

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[8] The maximum and the minimum varied across provinces. They were equal to about 3 and 7 *desyatinas* per male, respectively, in Russia's non-"black earth" regions, and about 2 and 6 *desyatinas,* respectively, in the black earth regions. (*Desyatina* is a measure of area: 1 *desyatina* = 0.37 acre.) "Step" provinces represented an exception, where the law determined the precise size of the peasant plot. If peasants cultivated more land before the emancipation than the legal maximum stipulated, the landlord had to cut both their plots and obligations. If peasants had less land than the legal minimum, the law mandated that the landlord to increase their plots. In practice, land cuts were more widespread than land extensions. The law also guaranteed the landlord a minimum of land that he or she could keep in his or her possession, even if peasants got less land than the legal minimum prescribed. The landlords' minimum also varied across provinces; it ranged from one-third to one-half of the total size of the estate. Landlords of estates with less than twenty-one male serfs had some additional privileges (Polnoe … 1863, vol. 36, part 1).

[9] Legally, all land belonged to the landlord under serfdom; the landlords allocated some part of their lands to peasants to run individual peasant farms on it.

[10] In the event of a mutual agreement, peasants could take one-quarter of the maximum land plot stipulated by law without any payment to the landlord, a so-called gifted pauper plot (*darstvennij nadel).* Peasants could also request a gifted pauper plot if the landlord initiated the buyout operation (Polnoe … 1863, vol. 36, part 1). About a million peasants, or about 4% of former serfs, got gifted pauper plots as a result of the land reform (Zajonckovskij 1968).

In the event that there was no mutual agreement, the buyout operation could be initiated at the request of either the landlord or the peasants under the terms specified by the law (Polnoe … 1863, vol. 36, part 1). An initiation of the buyout operation by the peasants or the landlord without a mutual agreement implied some losses for the initiator. If peasants launched the buyout operation, they could buy out only small plots around their houses in the village, but not the land they cultivated under serfdom, and they did not get a loan from the government. If the landlord launched the operation, peasants did not pay the initial twenty percent of the land price. Potential losses forced both peasants and landlords to search for mutual agreement, postponing the signature of the buyout contract and providing substantial sources of variation in the timing of the completion of the land reform. Landlords unsuccessfully lobbied for the abolition of the twenty-percent-reduction rule in the case of the launch of the buyout operation by the landlord (Lyashchenko 1913). For fifteen percent of former serfs, the signature of the buyout contract was postponed until the very end, i.e., till 1881, when a new law mandated an obligatory signature of the buyout contract no later than the beginning of 1883 for all peasants who had not yet done so (Polnoe … 1885, vol. 1). Historians (e.g., Zajonckovskij 1968) argue that the landlords had more bargaining power in bargaining over the precise terms of the land reform and land buyout contracts because of their monopsony power in local labor markets. Thus, landlords' incentives rather than those of peasants affected the speed of the implementation of the land reform. The gentry's indebtedness was an important factor that determined the landlords' incentives to postpone the reform.[11]

A7. Gentry's indebtedness

The government had provided credit to Russian gentry starting in the late 18th century. The landlords had the privilege of taking long-term loans, with serfs as collateral, from a state bank and other state financial institutions, which had the right to issue loans and take deposits (so called *Zaemnii bank, Sokharnnaya kazna* and *prikazi obshchestvennogo prizreniya*).[12] These organizations were the main source of credit due to the poor development of financial market. In total, about 44,000 thousand estates had debts, and about 7.1 million male serfs (about 63% of all serfs) were used as collateral by 1858 (Skrebitskii, 1862-1866 vol. 4). In an average province in our sample, this number is 59%.

On both the supply and the demand sides, the loans given to gentry were unrelated to economic performance. On the supply side, the government viewed credit as a means of securing the political loyalty of the gentry (Borovoj 1958). The enforcement of repayment was very mild. Gentry often successfully renegotiated the terms of their loans ex post. Borovoj (1958) reports many examples of refinancing and renegotiation of the terms of loans

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[11] State peasants, who were formerly free, were subjected to a land reform in 1866. The local authorities issued special commune land title documents (*vladennie zapisi*). These documents guaranteed former state peasants land usage rights in return for a fixed quitrent over the next twenty years, after which the quitrent was replaced by obligatory redemption payments. In the western provinces, redemption payments for former state peasants were introduced in 1867. The land plots that state peasants got as a result of their land reform were on average twice as large as the plots of serfs (Zajonckovskij 1968; Druzhinin 1978). Royal peasants went though the land reform in 1863. Their terms of land reform were similar to the terms of serfs (Zajonckovskij 1968). In the Baltic provinces, former serfs did not have land reform, as they did not have to buy out land.

[12] *Zaemnii bank* (1786-1860), *Sokharnnaya kazna* (1762-1860), and *Prikazi obshchestvennogo prizreniya* (1775-1864) were state banks. The state provided capital to them (Borovoj 1958). *Zaemnii bank* operated in Saint Petersburg. Its main purpose was crediting gentry. *Sokharnnaya kazna* had offices in Moscow and Saint Petersburg. It took deposits from the public and provided loans to gentry. *Prikazi obshchestvennogo prizreniya* (1775-1864) were provincial institutions with primary aim of providing finance to local schools, hospitals, orphanages, and prisons. They financed their primary activity from the interest they earned on loans issued to gentry. The estates were used as collateral for loans by state bank to gentry.

in favor of the gentry and only few examples of sales of estates because of bankruptcy. On the demand side, the gentry widely used state loans for status consumption (such as real estate in the capital cities, imported luxury goods, etc.) rather than for investment in production within their estates (Korf 1906). The number of landlords who used loans to invest into gentry' farms was negligible (Borovoj 1958). For example, according to Koval'chenko (1959), before the emancipation, there were only one hundred out of 8.5 thousand landlords in Ryazan and Tambov provinces, who invested into "modernization" of their estates. These two provinces were situated in the main grain producer region, where landlords mostly ran their own farms and demanded payments from their serfs in labor (corvee) rather than in kind (quitrent). Thus, it is likely that in other provinces, the share of landlords who invested into modernization of grain production was even smaller. Borovoj (1958) in his study of the history of credit and banking in 19th century Russia concluded: "*the loans, which the gentry got, were almost never spent to improve the productivity of estates, but were spent on consumption needs*" (Borovoj 1958 p. 181). He argued that the "*careless gentry*" composed the majority of those who got state loans (Borovoj 1958 p. 184). Overall, the special committee on the gentry's loans concluded in 1856 that "*the amount of loans in a province did not depend on its economic prospects ... the amount of loans was in direct relation with the amount of exemptions, privileges, repayment relief, etc. granted to a province at various moments in the past*" (cited in Borovoj 1958 p. 204). Importantly, these privileges were granted regardless of the local economic conditions. For example, the minister of internal affairs Sergei Lanskoi pointed out in 1856 that the gentry in Saratov province had the same amount of loans as the gentry in Vitebsk province while their economic development and prospects were very different (Borovoj 1958 p. 203).

The terms of credit for the gentry improved throughout the first half of the 19th century (Borovoj 1958). Four years before the emancipation of the serfs, the state decreased the interest rate for the gentry from five to four percent. In 1859, unexpectedly for the gentry, the government stopped issuing new loans because of financial problems caused by the defeat in the Crimean War (Lositskii 1906).[13]

As noted above, during the land reform, the state provided loans to former serfs to finance buyouts of land from landlords. The land prices were set to fully compensate landlords for their loss in income due to emancipation (the reform postulated the land price to be equal to capitalized quitrent), and the land buyout was obligatory. The state paid landlords directly with special bonds that had a 5% interest rate. The landlords got these bonds only if they did not have debts to the state themselves. Indebted landlords had to pay their debts back to the state before the buyout operation. Thus, for the landlords with debts, the buyout operation meant a drop in revenues, as the interest rate on the state loans, as a rule, was lower than the profitability of the gentry's estates both before and after the emancipation (Gur'ev 1904). By postponing the signature of the buyout contract, the indebted landlords gained a flow of revenue consisting of the difference between the interest rate on their loans to the state and the quitrent (lease) payments from emancipated peasants for the land, which the peasants had to pay before the buyout contract was signed. Lyashchenko (1913) provides examples of lobbying by gentry for the change in the regulation in order to abolish the obligatory deductions of the debts at the start of buyout operation. However, they managed to cancel this rule only in 1882, i.e., when the decision about the obligatory start of buyout operation by 1883 in all estates had been already taken (Lyashchenko 1913). The state provided loans to landlords with fixed maturity and stopped refinancing after 1859. As a result, the pool of indebted landlords who could enjoy this flow of revenue shrank over time. This practice

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[13] The government used private deposits in state financial institutions to finance loans. Following the rise in the budget deficit caused by the Crimean war, the Minister of Finance Piotr Brok lowered the interest rate on these deposits, which caused a run on state banks and resulted in inability to issue new loans (Borovoj 1958).

ended in 1881, when the government obliged all landlords to sign buyout contracts with their serfs during the following two years.

A8. The qualitative accounts of changes in the Russian countryside that occurred right after 1861 reform

The abolition of serfdom changed the Russian countryside. However, most changes took time. For instance, the implementation of land reform took up to twenty years, during which peasants had to fulfill "temporally" obligations to their former masters. It is important to understand which changes occurred right after the emancipation. Contemporaries described which changes occurred right after 1861 despite the fact that many landlords tried to prolong the "temporarily" transitional regime as long as possible.

The two key features distinguished this "temporarily" post-1861 regime from serfdom. First, the temporary regime was regulated by the government in the sense that the obligations of former serfs under the temporary regime were fixed and landlords could not change them. Article 4 of the emancipation Manifesto stated that peasants "*had to fulfill fixed obligations for landlords in the amount specified by Local Statues either in labor or in money*" (Polnoe … 1863). This change affected the incentives of both landlords and serfs. From the serfs' standpoint, Vetrinskij (1913) described a tale of a fugitive serf, Nikolaj Shipov, who decided to flee because his owner arbitrary increased quitrent payments. The importance of fixed peasants' obligations from gentry's standpoint becomes clear from the attempts of landlords to postpone the elaboration of the regulatory charters, which fixed the former serfs' obligations (Kornilov 1905). Druzhinin (1966) provides an example from Kaluga province in 1862 where local authorities recognized that "a number of landlords declared to the local peace arbitrator (*mirovoj posredniks)* that they would present their drafts of regulatory charters no earlier than on the last day provided by the law because they wanted to use forced labor of their former serfs as long as possible."

Second, landlords lost their coercive power. After the emancipation landlords could no longer whip or physically abuse in any other way their former serfs. Physical punishments of serfs by landlords were widespread before 1861 (Kornilov 1905). According to a case study by Hoch (1986), 20 percent of male serfs were subject to whipping at least once a year. Article 25 of the emancipation Manifesto stated that "*peasants could not be punished other than by the state authorities following a court decision*" (Polnoe … 1863). Landlords filed many complaints to authorities after 1861 about the difficulties in forcing peasants to fulfill their temporary obligations without the threat of physical punishment (Druzhinin 1966). Because of these difficulties, landlords had to move away from corvee to put their former serfs on fixed quitrent payments (Khorun 2003, Kornilov 1905, Druzhinin 1966, Tsagalov 1956). Thus, landlords' farms based on landlords' coercive power must have suffered from the emancipation. In contrast, the efficiency of peasant farms must have improved. Historical narrative (Druzhinin 1966, Najdenov 2003) and the materials of the Valuev commission (cited above) provide very few examples of successful landlords' farms based on free labor after the emancipation. Thus, the reorganization of landlords' farms is unlikely to be a driver of the increase in agricultural productivity documented in this paper. Some contemporaries correctly foresaw such outcome. For example, one of the thick journals of landowners, *Zhurnal zemlevladeltsev,* [The magazine of landowners] published a prediction that the liberated serfs

would get most benefits from the emancipation and that it would be difficult for private landlord farms to reorganize their business in a new environment (Tsagalov 1956).

Importantly, one needs to note that there was a rise of peasant unrest in the years following the emancipation. However, this unrest was driven by peasants' discontent with the suggested post-emancipation distribution of land between peasants and landlords, i.e., the land reform, rather than the emaciation per se, which peasants highly appreciated (Kornilov 1905; Zajonchkovskij 1973).

A9. Procedures for statistical data collection in the Russian empire of the 19th century

Provincial governors had to collect statistics on the economic and social development of their provinces, including figures on grain productivity and industrial output, since the late 18th century. The government formalized the procedure and obliged the governors to submit reports annually in 1802 (Minakov 2013; Prantsuzova et. al. 2016). Each governor's report consisted of two parts: a description and a statistical appendix.

According to Nifontov (1974), the official procedure for data collection was very detailed and deliberate. Governors relied on local officials and landlords on the ground to collect initial raw data at the district and sub-district levels. These data were aggregated into average provincial figures. The procedure required a lot of cross checking by various authorities. The central government carefully monitored the implementation of the data collection because the data were subsequently used to calculate tax redemptions and state transfers.

For statistics on grain yield, provincial administrations collected information on the amount of seeds put into the ground and organized so-called test threshing in a sample of estates to learn grain productivity per fixed amount of seeds. The provincial administration organized test threshing in each district of the province and in villages of all types, i.e., populated by serfs, state and royal peasants as well as free citizens. Nifontov (1974) pointed out that while the precise number of estates used for test threshing in each particular province in each particular year is unknown, it included several dozen estates. In their reports, governors included the total amount of seeds put into the ground and the total yield estimated as a product of the total amount of seeds put into the ground and grain productivity measured by test threshing. In our analysis, we use grain productivity, which is the ratio of estimated total grain yield to total seed.

As mentioned in the main text, Nifontov (1974) verified that the time-series of grain yields from the alternative sources, e.g., the reports on yields at state peasant farms from the Ministry of State Property, which are considered as a good-quality source, are highly correlated with those based on the governors' reports. Similarly, Fortunatov (1893) noted already in 1893 that data on yields from governors' reports are correlated with figures deduced from archives of individual estates. Litvak (1977) showed that the data on grain yields and on grain reserves are consistent. He argued that the data on grain reserves should be reliable because both central and local authorities paid a lot of attention to the question of food security, which was politically important as famines could trigger a revolt. In particular, he described how the Minister of Internal Affairs issued reprimands to governors and vice-governors for supplying poor-quality data on grain reserves.

One might argue that governors had incentives to underestimate the true grain output and productivity in order to get financial support for their provinces from the government. Even if that was the case, these incentives were uniform across governors and should not depend on the share of serfs in the province. Moreover, there is no reason to believe that governors' incentives changed with the abolition of serfdom. In addition, the rules for the data gathering procedures remained the same after the abolition of serfdom (Nifontov 1974,

Minakov 2013). In 1864-1865, the central statistical committee considered reforming the data gathering procedure in favor of direct questioning of all owners of farms about their output. However, after a consideration, the committee rejected this idea because of the low potential quality of such data (TsSK MVD 1883). Governors' reports remained the main source on grain output and productivity statistics until 1883 when the Central Statistical Committee adopted a new system, under which local statistical offices gathered data on cultivated lands, the amount of seeds put into the ground and productivity (the latter was still based on sample estimates) (TsSK MVD 1883). Litvak (1977) hypnotized that the quality of grain yield data improved with the introduction of zemstvos in thirty-four out of forty-six provinces after 1864. Table A13 shows that our results hold if we control for the zemsto expenditures.

A10. Agricultural technologies in the 19th century Russia

Technologies used in Russian agriculture in the 19th century were relatively primitive. Light wooden ploughs driven by horses were the dominant grain-production technology. The only fertilizer was manor, the supply of which was limited; according to agricultural specialists, the level of peasants' use of manor was one half of the amount that would maximize the grain output (Fedorov 1974). Agricultural machines, such as seeding and reaping machines, appeared in the Russian countryside in significant numbers only at the end of the 19th century (Fedorov 1974, Nifontov 1974). Machines and manor were simply too expensive for peasant farms. Individual landlords did try to employ machines and to expand the use of fertilizers in their estates before the abolition of serfdom (Department of agriculture, 1849). However, historians argue that their number was very small (Fedorov 1974). For example, Koval'chenko (1959) reported that about one hundred out of 8,500 landlords (i.e., 1.2% of landlords) in Ryazan and Tambov provinces tried to "*modernize their estates*" in various ways, including by adoption of new technologies. Koval'chenko concluded that these attempts did not affect the level of development of agriculture (1959 p. 112; 1967 p. 75).

Strumilin (1960) reports the labor inputs in the number of working days per unit of land (desyatina =1.0925 hectare) for growing winter rye in European Russia at three points in time: the 1850s, 1885-1889, and 1890-1917. Labor inputs per unit of land without a horse increased by 1.4% from the 1850s to 1885-1889, and by 4.45% from the 1850s to 1890-1917. With horse power, the labor input actually decreased by 16.3% from the 1850s to 1885-1889 and by 10.2% from the 1850s to 1890-1917 Strumilin (1960, p.146). This evidence suggests that the effects we found in this paper could not have been driven by the increase in the labor input alone.

The 19th century agricultural handbooks (e.g., Mordvin 1839, Usov 1840, Dmitriev 1844, Ungern-Shterenberg 1848) shed light on the kind of technological improvements that were readily available at that time. Some of these improvements were as sophisticated as new seed varieties and the introduction of multiple-field crop rotation, others as simple as a change in the timing and the order of existing agricultural operations.[14] Adaptation of these technological improvements did not require investments but did require exerting effort and care to make the adjustments. Mordvin (1839) singled out fifteen reasons for poor harvests, with six of them related to low effort. Ignatovich (1925) cited opinions of contemporaries and concluded that serfs worked poorly without constant monitoring, but even with monitoring they were about one quarter to one third less productive compared to free labor in terms of time required for any particular task (p. 160).

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[14] Over the second half of the 19th century, there was a gradual shift away from the three-fields system (an annual rotation of spring crops, winter crops, and fallow on the same plot) to multi-field crop rotation systems (Nifontov 1974).

A11. The rules of universal military conscription and the data on height

In 1874, after several years of discussion, the government introduced universal military conscription. The new rules of military draft replaced the old system based on periodical levies of recruits from localities, where the localities were responsible for choosing who should serve (Beskrovnij 1973). The new law postulated that every male subject of the empire had a duty to defend the country and, therefore, could be drafted to the army (Rediger 1900).

Ethnic exemptions. There were few exceptions to this rule of the universal conscription. In particular, a number of ethnic minorities (non-Russians) mainly residing in the outskirts of empire were completely exempt from military service. In the European part of the country, only kalmyks and native nomads in Astrkhan' province and native non-Russians in Mezen' district of Arkhangelsk province were exempt (Polnoe … 1874). In addition, the law stipulated different draft rules for Cossacks who had longer terms of military service in special Cossack regiments. Cossacks composed a substantial share of population only in Don and Orenburg provinces in the European part of the empire. According to 1897 population census, 40.2 percent of the population were Cossacks in Don province and 22.9% in Orenburg province (Trojnitskij 1905).

The size of the draft. In an average peaceful year, the size of the draft required for the imperial Russian army was less than one third of all males in the cohort of 21-year-olds. In the first decade after the introduction of the universal conscription (1874-1883), the population eligible for conscription varied between 0.75 and 0.84 million males in different years, whereas only about 27% of all 21-year-old males were annually drafted into the army (Vseobshchaya … 1886).

The procedure of the draft. The main steps of the procedure of the military draft, according to the 1874 law, were: universal male registration, the determination of exemptions based on family status and based on the result of a medical exam, and the conscription lottery among all eligible 21-year-olds for military service. The details of each of these steps were as follows:

1) All males had to register in the conscription lists at the age of 16. Local police was in charge of registration procedure. Failure to be registered by the age of 20 was a criminal and administrative offence. Unregistered males could not marry or become a public employee (Polnoe … 1874). According to the official sources, the number of males who managed to avoid registration was negligible (Vseobshchaya … 1886).

2) At the time of registration, exceptions based on family status were granted. They depended on the numbers of disabled and breadwinners in the household. There were three types of exceptions (ranked according to their strength). Family exemption of the first class gave a complete release from the military service, it was granted if the registered male was: the only son of a disabled farther or a widowed mother; the only brother of an orphan minor; the only grandson of a disabled grandfather or a grandmother without other relatives; the only son in the family. The second-class family exemptions were granted to the only able sons with able fathers and with minors or disabled brothers in the family. The third-class family exemptions were granted to brothers of drafted solders currently in the military service or of those who died in the army. The exemptions of the second and the third class were not absolute; the state could decide to draft individuals in

these classes if needed (Polnoe … 1874). In practice, they were not drafted during the period that we study (i.e., before draft year of 1888) (Gorskij 1910; Rediger 1900; Zajonchkovskij 1973). In an average province, there were 27.3, 19.6, and 5.7 percent of males with family exemptions of the first, second and third class, respectively. Altogether, they constituted 52.6% of all males registered males in the conscription lists. Rules of family-based exemptions did not change during the period we study.

3) In the fall of each year, all registered males, who turned 21 years old that year and who were not granted family exemptions were subjected to a medical examination, which included measuring height and chest size. On the basis of the results of these examinations, additional exemptions were granted, including those based on the requirements for height and chest size. We provide details of the medical exemptions below. A total of 14.7% of males got various medical exemptions.

4) Finally, all eligible 21-year-old males (i.e., after all possible exemptions had applied) participated in a lottery. The lottery determined individuals, who were drafted in each particular year. The total size of the draft was determined according to the military needs. The draft targets for provinces were proportional to the provincial male population.[15] Each individual was assigned a number according to a random draw. If the number of an individual was lower than a certain threshold (set by the authorities in each province according to the draft target), this individual was drafted to the army. The number of deserters was very low. For example, during the first decade of the universal conscription, below 3% of eligible males did not show up for the medical examination and conscription lottery (Vseobshchaya… 1886; Fedorov 1959).

Medical exemptions. The rules stipulated required minimum height, which did not change over time during the period under study, and the required minimum chest size, which did changed over time. The chest-size cut-offs depended on the height through a formula at every point in time.

The law defined the minimum height as 2 *arshins* and 2.5 *vershoks,* which is equal to 153.35 centimeters (Polnoe … 1874).[16] The minimum was lower than in other European countries in the same period. i.e., 160 in England, 162 in Germany, 154 in France, 155.3 in Austria, 156 in Italy (Rediger 1900; Gorskij 1910). In the first decade of the implementation of the universal conscription, only 1.49% of males in the empire and 1.45% in the European Russia were exempted from the military duty because of low height (Vseobshchaya… 1886).

The rules about the minimum ratio of chest size changed several times. These rules (as well as other details of medical examinations of the draftees) were set by the Ministry of Internal Affairs. The rules for the minimum chest requirements were as follows (Ministry of Internal Affairs 1877a, 1887; Sobranie … 1883; Rediger 1900):

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[15] The Ministry of War assigned regional conscription targets proportionally to the size of provincial male population, excluding males with privileges of the first class (Vseobshchaya … 1886; Rediger 1900). Within a province, local authorities also assigned draft targets proportionally to the number of males in the conscription lists (Polnoe … 1874; Ministry of Internal Affairs, 1877b).

[16] *Arshin* equals to 71.12 centimeters or 16 *vershok*s; *vershok* equals to 4.445 centimeters.

Years of draft:	Birth cohorts:	Minimum chest-size requirement:
1874-1881	1853-1860	½ height - ½ *vershoks* = ½ height - 2.2225 cm
1882	1861	½ height + ½ *vershoks* = ½ height + 2.2225 cm
1883-1884	1862-1863	½ height + 1/4 *vershoks* = ½ height + 1.11125cm
1885-1897	1864-1876	½ height - 3/8 *vershoks* = ½ height - 1.666875 cm
1898 and after	1877 and after	no chest-size requirement

In addition to family status and medical exemptions, there were special rules of draft for males currently in school above primary, there were also exceptions for those under criminal investigation and based on occupation. Participation in the lottery could be postponed until graduation from high school and middle school. (In 1874, this partial exception applied to 1.1% of males (Fedorov 1959).[17] Clergy, teachers, and doctors were except from military service completely (Polnoe … 1874). Males under criminal investigation and could not serve in the military, this applied to 0.16% of all males.

Original data on the height of draftees and challenges of identification. Military officials published data on height of males, who were drafted into the army and therefore passed medical examination. These data did not include Cossacks. The data were published for the years of draft: 1874-1887 and 1894, i.e., for each cohort born between 1853-1866 and the one born in 1873 (Vseobshchaya … 1886; Sbornik … 1887, 1890, 1897). We do not use data for 1873 cohort because these data are not comparable with data for 1853-1866 cohorts due to a change in reporting rules, on which there is a controversy about how to interpret it (e.g., Nefedov and Ellman 2016). Official volumes reported the number of draftees by nine height categories (eleven categories for a subset of years).[18]

The data report height of those, who were drafted into the army, i.e., those who considered eligible for the military service as a result of the medical examination. However, in order to construct a proxy for nutrition, we need to calculate a measure of height of *all* males, including those, who were exempt from military service because they did not pass medical requirements, e.g., had too low height or chest size. As we do not observe the height (or chest size) of those who were not eligible to military service, the average height by province calculated from official military height data may be biased. If this bias is different in provinces with different prevalence of serfdom, this would create a selection problem.

The minimum height requirement for draftees, in particular, could bias the estimation of the effect of the emancipation on height downward if, as one would expect, serfs were shorter than state peasants or free people and the emancipation led to closure of this gap. The reason for a negative bias is that before the abolition of serfdom, one should expect higher number of exemptions due to insufficient height in provinces with higher number of serfs before the abolition of serfdom, and therefore, upward bias in the measure of height in provinces with higher prevalence of serfdom before the emancipation. If abolition of serfdom led to an improvement in nutrition and, therefore, an increase in height, one should expect a decrease in medical exceptions due to insufficient height in provinces with a large number of serfs, and therefore, a smaller selection problem after the emancipation; which in turn would lead to estimates biased against finding a positive effect of emancipation of height.

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[17] Draftees with a high-school degree had to serve only for 6 months and draftees with middle school degree had to serve only for 18 months compared to the 6-year length of service for everybody else.

[18] These nine height categories are defined with a bit of ambiguity in the original sources and there is debate in the historical literature about how one should calculate the average height of draftees from them (Mironov 2000, 2003, 2013; Nefedov and Ellman 2016). We rely on the definition of categories provided by General Rediger (1900), who was one of the designers of the 1874 military draft reform. We have studied this literature and concluded that Rediger (1900) is the best available source.

The same logic would have applied to a minimum-chest-size requirement, if it were formulated in absolute terms, as height and chest size are positively correlated. However, the requirement for the chest size was formulated relative to height (as we described above), which may lead to biases going in different directions. Already in the late 19th and the early 20th century, medical literature established that, while the absolute chest size is increasing with height, the chest size relative to height is decreasing with height (Anuchin 1889, Gorskij 1910, Levitskij 1901, Sokolov 1903). Consider a possible effect of the change in the minimum-chest-size requirement that took place in 1882 and affected the cohort born in the year when serfdom was abolished on the height of draftees who passed medical exam and were considered eligible for service. If cohorts born before the emancipation were indeed higher on average in provinces with fewer serfs, the increase in the minimum chest-to-height requirement could have affected them more negatively, which would have resulted in a positive differential effect of the 1882 draft reform on height. In other words, the formulation of the minimum-chest-size requirement in terms of height could have potentially led to a bias in favor of finding a positive effect of emancipation of height, which is particularly problematic, if one does not correct for this bias.

Data on chest size and height distribution and the calculation of the average height of draftees by province corrected for biases created by medical exemptions. To address these identification concerns, outlined above, we studied the late 19th and early 20th century literature on anthropometric characteristics of Russian males and found disaggregated data on height and chest (Anuchin 1889, Gorskij 1910, Kupriyanov 1891, Levitskij 1901, Oranskij 1911, Sokolov 1903).

The most detailed data come from a Ph.D. dissertation of Gorskij (1910). He reports data on all males who were subjected to a medical examination in order to assess their fit for military service in Borbujsk district each year in 1874-1899. The data include the distributions of chest size (including, minimum, maximum and average) by height groups. Importantly, these data include all those who were exempt from military service because of the insufficient height or chest size. Gorskij compiled these data from original individual conscription documents of 45,879 males measured during the medical examinations in 1874-1899. There were 1,166 males who were measured during the medical examination in 1874; and 2,145 in 1899. The data are reported by religion. Among the 45,879 males considered for military service in Bobruisk district, 69.3% were Orthodox Christians, 23.5% were Jews, 4.4% - Catholics, 2.6% - Old Believers, and 0.2 – Protestants. The share of Jews was particularly high because the district was located in the Pale of Settlement of the Russian empire. We use data for Orthodox Christians because the height of an average Orthodox Christian from the Bobruisk district (164.5 centimeters, Gorskij 1910) was close to the average height of males in the European Russia (164.2 centimeters, Anuchin 1889).

Table A8 in this online appendix reports the minimum and maximum chest sizes of males by height categories that satisfied the minimum height requirement for military service (i.e., taller then 153.3525 centimeters). We assume that there is a one-to-one correspondence between chest size and height in each height category such that: the smallest individual in each category has both the minimum chest size and the minimum height in that category; the biggest individual has both the maximum chest size and maximum height in that category; and there is a linear relationship between chest size and height of all other individuals each category. Under these assumptions, we estimate the share of males in each height category, who did and who did not satisfy the minimum chest requirement under each version of the minimum-chest rules (i.e., those affecting cohorts born before 1861, born in 1861, in 1862-1863, and 1864-1876). Using these figures, we adjust the average height of draftees in each category and overall for the potential effects of the minimum-chest regulations. In the

baseline estimation, we use the adjusted height figures. In Table A10 in this online appendix, we report results for the unadjusted height figures. (The results are robust, which suggests that the selection issue is not important in practice). However, one needs to be cautious in interpretation of the results, as our correction of the height measures for a possible selection is based on the assumption that the relationship between chest size and height of Orthodox males in the district of Bobruisk is representative of this relationship in all European provinces of the Russian Empire.

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B. Additional information about the data and the construction of variables

B1. Governor reports:

Original copies of governor reports are available in the archives. The government and historians published grain productivity and industrial output figures based on these reports for selective years. Table A1 lists all years for which we have grain and industrial output figures. For grain productivity, we do not have data in the following years: 1796-1800, 1830-1839, 1867-1869, and 1877-1882. The selection of the sample is not driven by poor or good harvests. The list of famine years does not correlate with the years of missing data: 1812, 1833, 1839-1840, 1844-1846, 1867, 1872-1874, 1891-1892, 1897-1900 (Golodi, 1868; Egorishev, 1985). We do not have data for two out of sixteen famine years.

B2. Formula for the land reform implementation proxy:

The land reform implementation variable is the ratio of the estimated number of (former) serfs who signed buyout contracts and the total rural population. We estimate the number of (former) serfs who signed buyout contract in the following way.

a. For years 1862-1876 and provinces outside former Polish-Lithuanian Commonwealth:

$$Peasants\_with\_signed\_buyout\_contract_{it} = \frac{Total\_Redemption\_Payments_{it}}{Redemption\_Payment\_Per\_Serf_i}$$

where i indexes provinces; t indexes years;
$Peasants\_with\_signed\_buyout\_contract_{it}$ is a proxy for the number of (former) serfs who signed buyout contracts;
$Total\_Redemption\_Payments_{it}$ is the redemption payments per province and year from the redemption payment statistics;
$Redemption\_Payment\_Per\_Serf_i$ is the average redemption payment per (former) serf in 1877; it is calculated as follows:

$$Redemption\_Payment\_Per\_Serf_i =$$

$$= \frac{Projected\_Total\_Redemption\_Payments_{i,1877}}{Peasants\_with\_signed\_buyout\_contract_{i,1877}}$$

where $Projected\_Total\_Redemption\_Payments_{i,1877}$ is the linear projection of total redemption payment per province from 1870-1876 data;
$Peasants\_with\_signed\_buyout\_contract_{i,1877}$ is the number of (former) serfs who signed buyout contract by 1877 from official statistics.

b. For the year 1877 and provinces outside former Polish-Lithuanian Commonwealth:
We take these data from official statistics.

c. For the years 1878-1882 and provinces outside former Polish-Lithuanian Commonwealth:
We make a linear projection by province from the estimates of 1870-1877.

d. For the years starting with 1883 and all provinces:

The number of (former) serfs who signed buyout contracts is equal to the number of former serfs.

e. For the former Polish provinces:
In the year 1862, for Kovno, Vilno, Grodno, Minsk, Kiev, Mogilev, Podolsk, Vitebsk, and Volhyn, the number of (former) serfs who signed buyouts contract is estimated in the same way as for non-Polish provinces (see above) and, from year 1863 onwards, it is set to the number of former serfs.

B3. The construction of the variable for the number of monasterial serfs:

Beskrovnii et al. (1972) report the number of various subcategories of monasterial and clerical serfs by districts in all provinces of the Russian empire, including the provinces of the former Polish-Lithuanian Commonwealth, in 1796 and 1814, i.e., for the 4th and 5th tax censuses. (Such data do not exist in the later censuses, whereas the earlier censuses did not cover the provinces of the former Polish-Lithuanian Commonwealth because they were not a part of the empire at that time). We combine all these subcategories to estimate the average shares of such serfs in each district and each province between in 1796 and 1814. We do that in 1858 district borders, matching 1796 and 1814 districts with 1858 districts by the location of their capital towns in 1858. For a number of provinces and districts, we do not have data for one of the two years, 1796 or 1814. Most of the time, this occurs because the source reports some subcategories of former monasterial serfs together with state peasants. In these cases, we use the year for which the data are available for the corresponding location.

B4. Data on inputs into the agricultural production:

There are no data on labor inputs for agriculture in the 19th century. Employment in agriculture is known only for the 1897 population census year. The figures for the population with rural legal status (even if these people worked in cities) are known only for tax census years (1795, 1811, 1816, 1851, and 1858). Data on cultivated land are available for 1800, 1858, 1871, and 1877. There are no data on investments into land.

B5. The definition of the 14 regions:

1. North: Arkhangelsk, Vologoda and Olonets provinces;
2. North-West: Novgorod and Pskov provinces;
3. West: Smolensk, Vitebsk and Mogilev provinces;
4. Belorussia and Lithonia: Minsk, Grodno, Vil'no and Kovno provinces;
5. Central Industrial Region: Vladimir, Nizhnij Novgorod, Kostroma, Yaroslavl' and Tver' provinces;
6. Central Black Earth Region: Kaluga, Tula, Ryasan', Orel, Tambov, Kursk, Voronezh provinces;
7. Middle Volga: Kazan', Penza and Simbirsk provinces;
8. Left Bank Ukraine: Chernigov, Poltava and Khar'kov provinces;
9. Right Bank Ukraine and Moldova: Kiev, Podoliya, Volyn' and Bessarabiya provinces;
10. South: Kherson, Tavrida, Ekaterinoslav and Don provinces;
11. Low Volga: Saratov and Samara provinces;
12. South-East: Astakhan' and Orenburg provinces;
13. Urals:, Vyatka and Per'm provinces;
14. Capitals: Moskovskaya and Saint-Peterburgskaya.
In addition, Estlyandiya, Liflyandiya and Kurlyandiya provinces composed the Baltic region.

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